POWER PLANT ENGINEERING

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A Fuel-Oil Installation

ONE OF THREE BOILER ROOMS OF AN OLD PLANT WAS EQUIPPED FOR OIL-BURNING TO INCREASE THE STEAMING CAPACITY WITHOUT ADDITIONAL BOILERS, ELIMINATING A COSTLY METHOD OF COAL HANDLING AS WELL. BY H. A. WILCOX

BEFORE STARTING OUT upon the description of the actual installation, a brief explanation of how we came to decide upon using fuel oil may be of interest. Figure 2 gives a general idea of the layout of the plant as affecting the particular problem. The entire plant is not shown, but only enough to show the main steam producing parts. There are three boiler rooms, known as the upper, the lower and the new boiler rooms. In the lower boiler room there are seven horizontal return-tubular boilers of about 175 hp. each. The upper boiler room is similarly equipped and the new boiler room has only five of the same type boilers; however, the upper and lower boiler rooms are operated at 125 lb. pressure and the new boiler room at 150 lb. pressure.

FIG. 1. GENERAL VIEW OF THE WHOLE PLANT. AT THE EXTREME LEFT ARE THE STACKS OF THE LOWER BOILER HOUSE, AND TO THE RIGHT THOSE OF THE UPPER, AND NEW BOILER HOUSES. MAIN STORAGE TANK IS BEHIND UPPER BOILER HOUSE

In the latter part of 1918, the writer was connected with this mill in the capacity of efficiency engineer for a few months; subsequent to that he was made mechanical superintendent of the plant. While employed as efficiency engineer, he studied the steam requirements and possibilities of the plant and came to the conclusion that some radical step would have to be taken if the entire mill were to be kept in full operation the next winter. This was deduced from the fact that tests showed that the draft over the fire in the upper and lower boiler houses was only about 1/10 in., or slightly better, and that the boilers were being pushed as hard as possible at that time. There were apparently only three methods of accomplishing the desired results: (1) install more boilers; (2) install forced draft under the present boilers in the upper and lower houses; (3) install fuel oil in one of the boiler houses. It might be as well to mention at this point that the laws of the State do not permit of connecting together two batteries of boilers running at different pressures, under any circumstances. It was therefore impossible to get the necessary increased capacity from the new boiler house which we could have otherwise done as this house had a fine draft and a surplus of steam.

Considering the three solutions given above in order: Installing more boilers meant perhaps a long wait; enlarging the boiler houses to accommodate them; and more firemen, with perhaps the building of new stacks to furnish the necessary additional draft. Therefore this scheme was rejected. Installing forced draft in the upper and lower boiler houses meant more firemen; more ashes to handle; clinker trouble; more frequent furnace repairs; and trouble with labor all around. In fact, this last item, of labor, had a great deal to do with deciding the issue in favor of oil. It, therefore, seemed best to install fuel oil. The next question was, where to install it.

The boilers in both the upper and lower houses were

of about the same age (20 yr. old on the average). Age, therefore, was not a determining factor. It will be noted in Fig. 2 that a trestle enters the yard near the upper and new boiler houses. The plant is located too remotely to permit of oil deliveries by motor truck and, therefore, the railroad had to be depended upon. On this account, we would have to receive oil in tank cars and our main storage tank would have to be located somewhere near the trestle. All the coal used in the lower boiler house was unloaded at the trestle and carried in wagons through the yard to the boiler house. This involved a considerable expense in labor and teams; therefore, in order to get rid of this expense, it was decided to install the oil at the lower boiler house and save the expense of the long coal hauls. In fact, this was also one of the main reasons for installing oil at all, as the saving in this item alone would go a long way toward paying for the installation.

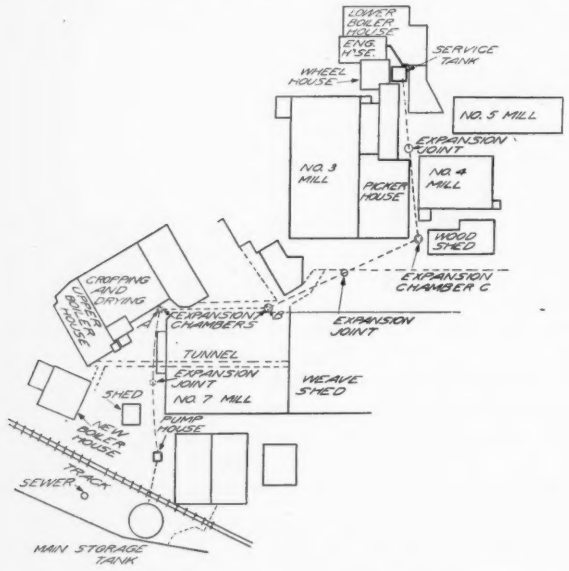


FIG. 2. PLAN OF PLANT SHOWING LOCATION OF OIL EQUIPMENT

The next question that came up was as to whether it would be feasible to pump the oil the long distance it would have to go to reach the lower house. In winter the temperature sometimes goes to 10 and 15 deg. below zero and some doubt existed as to whether the oil would not be too thick and heavy to be successfully pumped this distance when the temperature outside was at its lowest. This matter was carefully studied and it was decided that it was perfectly possible, provided that means were provided to warm the oil while it was being pumped. Warren B. Lewis, Consulting Engineer, of Providence, R. I., was called in to make plans and specifications covering the complete job and to superintend the installation.

The next question to come up was whether we should install steel storage and service tanks or tanks made of concrete. At that time, 1919, promises on steel tank deliveries were rather uncertain and after much deliberation and consultation, concrete tanks were decided upon.

Main Storage Tank

Work on the main storage tank, Fig. 3, was started about the first of September, 1919. As will be noted from the specifications, it was necessary to build the main tank partly under ground to conform with the insurance requirements and finally to cover the tank with a foot or two of earth after it was finished. The first operation, therefore, was to excavate a hole sufficiently deep to hold part of the tank. The digging was almost all solid ledge and a great deal of blasting had to be done. Water was encountered early in the digging and we had to rig three or four steam siphons in order to carry on the job. The entire job was carried out according to specifications, however, the bottom being poured in one day and taking about 10 hr. About two weeks later the sides were poured, taking about 15 hr. The joint between the bottom and sides was prepared according to specification and the sides were thoroughly puddled while being poured. For this purpose, long bars were made, similar to the slice bar used in the boiler room, and three or four men were stationed at short intervals around the sides whose only duty was to attend to this job. Finally, the roof slab was put on and the job was finished.

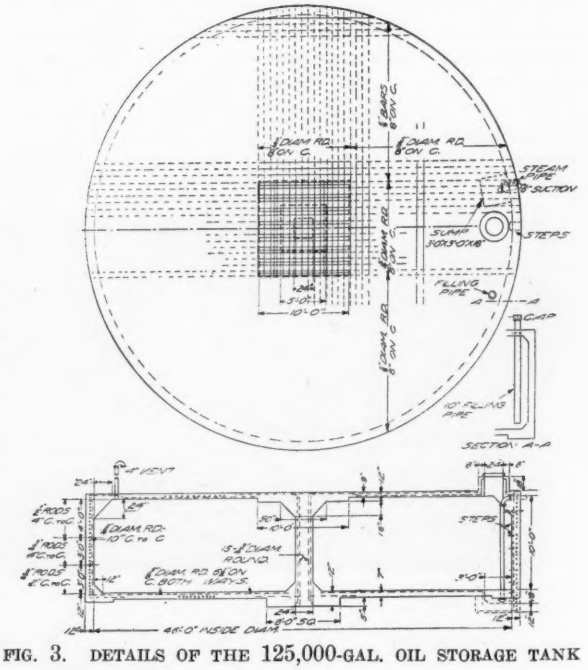


FIG. 3. DETAILS OF THE 125,000-GAL. OIL STORAGE TANK

After a lapse of about three weeks from the pouring, the forms were removed and the tank allowed to dry out thoroughly, both outside and inside. A very smooth job was the result and the next thing was to test the tank for tightness. There were a few small voids visible from the outside. Several steam coils were installed inside the tank to aid in drying it out. After the tank was thoroughly dried out, it was filled with water and the height of the water measured from a fixed point. After standing for 24 hr., another measurement was taken and the difference between the measurements showed that there was a slight leakage. All visible leaks on the outside were patched up with a mixture of equal

parts of iron cement and fine sand. Another water test was tried and great improvement shown. There was still a slight leak and the tank was therefore emptied and all voids on the inside were patched up and a couple of coats of iron cement and sand were applied internally as on the outside. The subsequent water test showed that the tank was absolutely tight and that this part of the work had been successfully brought to a conclusion.

In laying out the forms for the bottom and sides of this tank, an interesting expedient was used. It will be noted from the drawing that the tank was 48 ft. in inside diameter and an almost perfectly cylindrical tank was obtained by the use of a large trammel. A large block of iron was placed at the bottom of the excavation and was eventually covered with concrete. This block had a hole in its center to accommodate a shaft about 3 in. in diameter. The upper end of this shaft stood about 8 ft. above the point at which the top of the tank was to come. At its base and near the iron block, an arm about 24 ft. long and at right angles to the shaft was fixed. This arm was supported from the top of the shaft by means of guy wires and trusses fixed to the shaft itself and carried at its outer end a pointer which was exactly 24 ft. from the center of the vertical shaft. The whole instrument could rotate through 360 deg. and thus mark out a circle of the exact diameter desired. The inside boards of the side wall forms and the bottom of the tank were laid out by means of this trammel, or compass and,

FIG. 4. COMPLETED TANK AFTER FORMS WERE REMOVED AND BEFORE PITCHED ROOF WAS LAID

as stated before, a good job resulted. The specifications of the storage tank are given below.

SPECIFICATION OF REINFORCED CONCRETE STORAGE TANK

THIS SPECIFICATION describes the construction of a reinforced concrete fuel oil tank as shown in Fig. 3.

As the tank must be oil proof, this quality must be obtained by properly proportioning the concrete. The proportions shall be such as to obtain the greatest practical density, and concrete should be mixed to a mushy consistency. Nine per cent by weight, of dry materials, will give a suitable mixture.

The cement shall be a standard brand of American Portland cement, which has been successfully used for reinforced concrete work for at least 3 yr., and shall conform to the requirements of the latest specifications adopted by the American Society for Testing Materials.

The sand used shall consist of clean, sharp, coarse grains, uniformly graded in size, the largest grain not to exceed ¼ in. in diameter. It shall contain not more than five per cent of clay or loam, and shall be free from all other impurities. A sample of the sand to be used should be submitted for testing.

Crushed stone or gravel shall be used for all concrete. It shall be composed of hard, sound particles, screened or washed free from clay, loam, fine sand, and crusher dust. It shall be uniformly graded from ¼ to ¾ in. in greatest diameter.

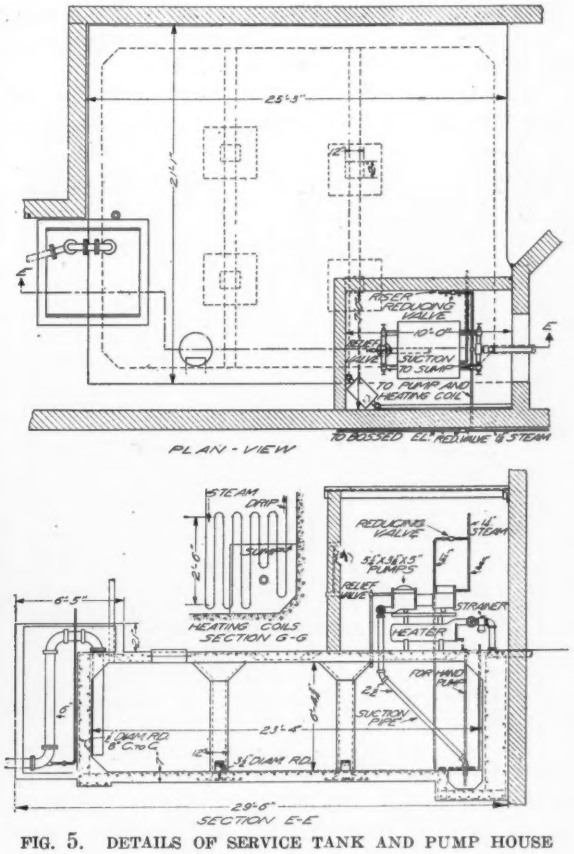


FIG. 5. DETAILS OF SERVICE TANK AND PUMP HOUSE

The water used in mixing the concrete shall be fresh, clean, free from all earth, dirt and sewage, or other impurities liable to injure the concrete.

Concrete shall be mixed in the proportion of one part of cement to six parts of aggregate, measured separately. Proportions shall be measured by volume, taking one bag, containing not less than 94 lb. of cement, equal to one foot.

The proportions of sand and aggregate shall be chosen so as to give a concrete of maximum density. In no case, however, shall the proportion of sand be less than 40 per cent of the aggregate.

All concrete shall be machine mixed. The machine used shall be a "batch mixer," and the product delivered from the mixer shall be of the specified proportions and consistency, and thoroughly mixed.

The concrete shall be mixed wet, sufficient water

being used to make a mass which will flow readily, and be of such consistency that the reinforcing steel will become covered with a protective coat of fine mortar, while at the same time being careful to avoid an excess of water, as this produces a separation of the ingredients.

After the mixing of the concrete, as specified above, it shall be carried immediately to the point of construction and placed in the forms. When placed in the forms, the concrete shall be thoroughly puddled, and exposed faces worked so that a smooth finish will result.

For reinforcement, use corrugated round iron bars or other approved deformed bars, used in as long lengths as possible. Laps must be 40 diameters in length, and well wired together. The bars should be accurately laid as shown on the drawing. At points of inflection, it is desired that bars be not bent at the same point, but the zone of bending should be 2 ft. wide.

In all inside corners forming junctions of sides and walls, there should be formed fillets measuring 15 in.

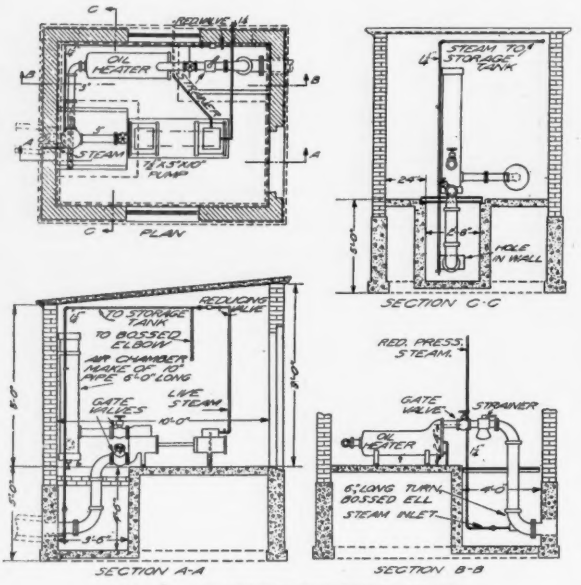


FIG. 6. TRANSMISSION PUMP HOUSE

on the slanted face. These fillets should be cast in and not placed in position after the tank has been poured.

The tank should be poured as continuously as possible, so as to make it as nearly a monolithic structure as practicable. It will probably be necessary to pour the structure in three stages:

(a) The bottom of the tank;
(b) The side walls and central column, and
(c) The roof slab.

At the joints between stages, the concrete already laid should be roughened, thoroughly cleaned of foreign material, drenched and slushed with mortar consisting of one part of cement and one part sand.

The bottom of the slab will slope a total of 6 in. towards a slump 36 in. square and 18 in. deep.

The depth of the tank at the shallowest portion, will be 10 ft.

One manhole, made according to sketch, is to be installed.

One set of steps, made of reinforcing bars, ½ in. in diameter, and placed 15 in. apart in the concrete, should be placed at the manhole.

The contractor should provide close inspection, as the nature of the structure demands absolute absence of defects which might tend to cause oil leakage.

The Service Tank

After the main storage tank was completed, work was started on the small storage tank located near the lower end boiler house. The accompanying photograph and drawings clearly illustrate the construction of this tank and little need be said.

The puddling was not as carefully done on this tank as in the case of the first one and our water tests repeatedly showed bad leaks. To overcome these leaks, we plastered the entire interior surface of the tank with several coats of a mixture composed of equal parts of iron and Portland cement. This finally had the effect of stoping the leaks and the tank was ready for use.

In the meantime, the construction of the two pumphouses, Figs. 5 and 6, was progressing. As a matter of fact, the pipe line was ready before either of the two tanks were completed. A large part of the digging for the pipe line was through rock and a great deal of blasting had to be done in certain places.

As the mill has been in business for over 100 yr., numerous dead pipes and sprinkler pipes and other underground pipes were encountered. This made fixing the grade of the pipe line a somewhat difficult undertaking and it was laid by rule of thumb, largely. It will be noted, that there are few bends in the entire line and that these are taken care of by means of special expansion chambers. The only bend not so taken care of was going over the tunnel shown entering No. 7 mill. At this point, the top of the tunnel is only a foot or so under the surface and we desired to get the pipe line below the frost line if possible. The only way to have done this would have been to go under the tunnel. This course was abandoned, as it would have been necessary to go too deep. We therefore decided to go over the tunnel. As winter was approaching and deliveries were uncertain, we could not wait for a special pipe bend to be made.

Our main line was laid about 5 ft. under ground on each side of the tunnel and we therefore had to offset the pipe about 3 ft. The question was: How to bend the pipe, which was 6 in. in diameter. We finally made up a wooden form and bent the pipe cold. Of course, the joints could not be screwed together after the pipe was bent, so we had to have recourse to flanges. Some doubt was raised as to the expansive action of the 1¼-in. pipe inside the 6-in., but I am happy to state that in actual operation this has worked out nicely and no trouble whatever has been experienced from this source. One of the expansion joints in the pipe line together with one of the specially designed pipe chairs is shown in Fig. 7. There were 75 of the chairs used on the whole job. Where the pipe line crosses the river, it was first supported on concrete piers, so placed that a sharp edge was opposed to any ice which might come down the river in winter. The pipe and expansion chamber were next covered with a layer of cheap hair felt. Outside of this came a layer of roofing paper and then a layer of rubberoid roofing material on top. The joints in the rub-

beroid were all cemented together and then the whole line was given two coats of black asphaltum paint. This line has stood up well all winter and this winter has been the most severe experienced in these parts in many years.

The whole job was carried out exactly according to the following specifications and has proved a complete success.

Oil Storage Tank

Under this heading reference only is made to the piping work which is a part of this tank.

Figure 3 shows a 6-in. oil suction and two 1¼-in. steam pipes entering the sides of the tank just under the roof, an oil filling line, and a vent pipe. The vent pipe is 4-in. The lower end is to be embedded into the concrete, by being set on the forms before the roof is cast, and is to extend 4 ft. above the top of the tank, and terminate in a return bend.

The oil filling line is 10-in., standard weight pipe, and is also to be embedded in the concrete, the bottom terminating about 10 in. above the floor of the tank, the top projecting about 18 in. above the roof, and having a tight cap which is to be screwed on the pipe when the tank is not being filled.

The 6-in. suction line enters the top, turns downward with a long turn elbow, and terminates about 5 or 6 in. from the bottom of the sump. Surrounding this suction pipe is a steam coil, to be of 1¼-in. pipe, the joints to be welded, the convolutions to be about 4 in. apart on centers, and the diameter of the coil slightly less than 24 in., so that it will pass down through the manhole in the top of the tank. The lower end of the coil is to terminate in a threaded end, so that an elbow can be attached for running the drip line up toward the top of the tank. (This coil should be piped up and tested out with 100 lb. pressure, to make sure that there are no leaks.) (Author's Note.—This coil was actually constructed without a joint in the whole coil. There was no threaded end at the bottom but the pipe was bent around and brought up through the inside of the coil to the top of the tank. In this way, there were no joints to leak and the coil was tested at 125 lb. pressure before being placed in the tank. Figure 8 shows the coil just before it was lowered into the tank. The method of maintaining the distance between the convolutions is clearly shown and these straps were utilized for supporting the coil upon the floor of the tank. The coil was made so accurately that it was necessary to file off the shanks of the bolts which projected above the nuts holding the straps before the coil would go through the manhole which was exactly 24-in. inside diameter.)

All screwed joints are to be made up with glycerine and litharge, and this applies to all of the work wherever the pipes are in contact with oil.

In connection with this, note the manner in which the oil and steam pipes are brought to the tank. This is indicated in a section in the lower right hand corner of Fig. 3.

Build a runway or conduit of concrete from the tank down to and into the foundation of the pump house. This conduit will carry the oil pipe and the steam and return pipes. Where these pipes rise to enter the top of the tank, they are to be enclosed in a concrete vertical box, which can be covered at the top to keep the water out. Some standard form of pipe roller and bearing can be used inside of the concrete conduit to support the pipes and to allow of free motion for expansion. This part of the pipe line should be about 4 ft. under ground. (Author's Note.—Not finding a standard form of pipe roller, which seemed suitable, the writer designed the roller shown in Fig. 9 and this was successfully used through the whole job.)

Pump House

This is a completely fire-proof building, Fig. 6, and will contain the pump for pumping oil through the pipe line, an air chamber, a pre-heater, together with various pipes, valves, etc., for controlling the pump and the temperature of the oil.

The level of the floor of this pump house is to be about 6 in. above the surrounding grade.

FIG. 7. ONE OF THE MANHOLES UNDER CONSTRUCTION, SHOWING AN EXPANSION JOINT AND ONE OF THE PIPE CHAIRS

The foundation walls are to be of concrete, and there are two pits in the house, one for the incoming pipes and one for the outgoing pipes. Rebates are left at the top of these pits so that an iron grating floor can be laid over them. Leave holes in the foundation walls for the entrance and exit of these pipes.

The walls are to be 8-in. brick. The sash are to be steel sash, fixed, embedded in the walls. The roof is to be a 2¾-in. concrete slab, reinforced with steel mesh. The door is to be an approved fire door, swinging into a rebate in the brickwork.

Figure 6 shows the setting of the pump, heater, etc., in this pump house. It is assumed that the concrete conduit has been laid from the oil storage tank down to the wall of the pump house and joined to the latter. A 6-in. pipe is shown entering on the side opposite to the door, and at a level of about 3 ft. below the floor. It turns up and is reduced to 4-in. through a 6 by 4-in. reducing elbow, and is attached to the pump with a 4-in. gate valve in between.

The oil heater is to stand on the floor next to the outside wall. To the discharge outlet of the pump,

attach a 4-in. gate valve, and run 3-in. pipe to the air chamber. This air chamber is to be fabricated and is not a part of the pump or heater equipment furnished by the oil burner contractor. The inlet and outlet pipes to the chamber can take the form of couplings, electrically welded into the pipe, which is probably the cheapest way to make connection. There is to be a 1¼-in. drain at the bottom of the chamber.

This chamber is to be carried on a 4-in. I-beam which spans the inlet pit. From the air chamber, run to the heater, as shown.

Steam for this pump house is to be brought from the boiler house and taken directly from the main header in the latter. It will probably be advisable to run a 2-in. pipe overhead, giving it proper support and thoroughly insulating it.

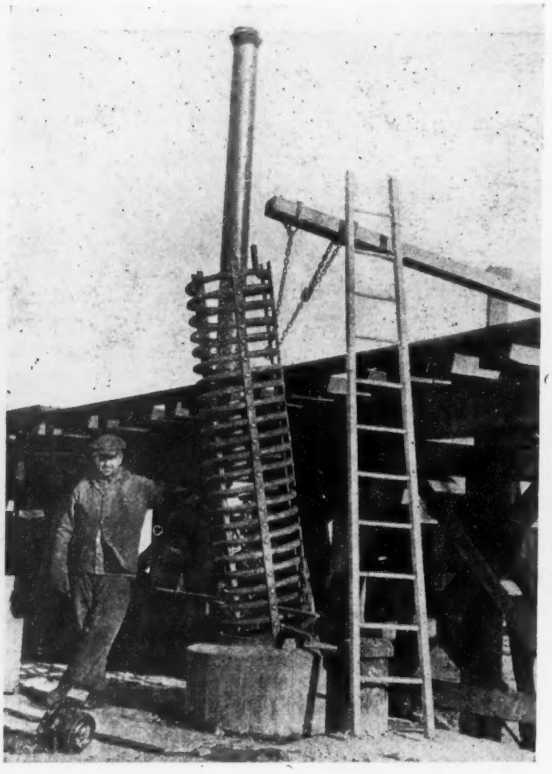


FIG. 8. STEAM HEATING COIL FOR STORAGE TANK

In Fig. 6 the pipe is shown as 1¼-in., entering the Exhaust steam pipe from the pump is carried in a groove in the floor over to the heater, and will pass through the latter to an outlet pipe which is to be carried through the wall of the pump house to act as a free exhaust.

The strainer on the oil heater outlet is furnished by the oil burner company.
side of the pump house. A 1-in. branch is carried over to the pump and connected to the steam end of the latter. Another branch passes through a reducing pressure valve to reduce the steam to about 15 lb. pressure; and beyond this are two branches, one of which will lead to the main storage tank and one to the bossed elbow near where the 6-in. pipe leaves the building.

The reducing pressure valve should be of the spring-loaded diaphragm type.

Service Tank

THE LOCATION of this tank is shown in Fig. 2 and details in Fig. 5.

This tank is to occupy all of the available space between the wheel house, boiler house, and the two engine houses, allowing only sufficient space on the south side of the tank for the passage of sprinkler pipes and blow-off pipes which will have to be moved from their present location.

The bottom of this tank is to be built immediately on top of the stone arch which forms the tail race of the water wheels.

On account of irregularity of the old building foundations, the exact thickness of the walls of this tank cannot be specified until the excavation has been made. The drawing shows, however, a thickness which is probably ample to guarantee a thickness of at least 10 in. of solid concrete outside of any of the stone work.

The specification which has been made for the concrete of the oil storage tank, will apply to this tank, and inspection will be given during its construction.

The oil line enters this tank through the top, and is brought up from its underground level through a concrete box, rectangular in shape, which can be covered with planks to keep out the weather.

The service pumps and heater are located on top of this service tank, and are enclosed in a fire-proof building, two walls of which will be the walls of the present buildings. This pump house has a concrete roof, similar to that specified for the pipe line pump house.

The general piping connections are about the same, i.e., provision has been made for supplying the pumps with steam at boiler pressure, and there is a branch through a reducing pressure valve for supplying steam to the heating coil in the tank. This coil is a flat return bend coil, laid on the bottom and just above the sump. Great care must be taken in putting this coil together, to be sure that it does not leak; and it should be tested out at 100 lb. pressure.

In Fig. 5 is shown the steam connection. There is an additional reducing pressure valve, for furnishing low-pressure steam to the line which will be run inside the oil pipe. This team line will be run inside the neighboring building, and will come through as shown in the plan.

Pipe Line

FIGURE 2 shows the general run of the pipe line and some details.

The oil line is 6-in. This is to be standard weight pipe with ordinary screwed joints, except where the pipe joins to expansion joints or special fittings, where they are to be flanged joints.

All fittings are to be of the long turn pattern, and this applies to all pipes carrying oil, wherever they may be installed, in connection with this installation.

All joints are to be made up with glycerine and litharge. Exceeding care will have to be taken when laying the pipe and making up joints, to insure that it is as tight as it is possible to make it.

(Continued on page 527)

New Unit in Fisk Street Station

A Description of the New 25-Cycle 35,000-Kw. Tandem-Compound Steam-Turbine Unit. By F. A. Hatch

THERE has been recently put into operation at the Fisk St. Station of the Commonwealth Edison Co., Chicago, a 25-cycle tandem-compound steam-turbine unit of 35,000 kw. rating. This unit consists essentially of separate high and low-pressure cylinders on a continuous shaft and is direct-connected to a 35,000-kv.a., 100 per cent power factor three-phase, 25-cycle, 9000-v. generator running at 1500 r.p.m. synchronous speed. The generator has its own 135-kw., 230-v. shunt-wound exciter mounted at the collector end.

Some idea of the size of the unit may be obtained from the following over all dimensions; the approximate length is 70 ft., the width 17 ft., and the height 18 ft. 4 in. above floor line. The top of the bedplate, the depth of which is 3 ft. 4 in., is flush with the floor-line. The total unit weighs approximately 1,200,000 lb.

By employing the tandem-compound arrangement, the total expansion of steam is carried out through two separate elements, thus securing for each element a satisfactory temperature difference between its own inlet and exhaust ends and thereby reducing to a safe value the stresses which would cause distortion of the turbine spindles. It also permits a shorter distance between bearings of the rotor, consequently securing a greater ruggedness and reliability which would not otherwise be possible in a single cylinder unit of this capacity. This construction, besides leading to better reliability of the unit, also tends toward a better efficiency; blade lengths and velocities can then be proportioned to give their highest efficiencies. Where the total steam expansion is carried out in a single element of this size, some sacrifice in efficiency must be made at the extreme high- and low-pressure stages in order to secure a well-balanced design.

The unit has five main self-alining bearings supporting the rotating elements and one small outboard bearing for the exciter. The turbine itself requires three of these; two for the low-pressure and one for the high-pressure elements; the latter located at the governor end. The bearing between the high- and low-pressure cylinders serves to support both spindles. The two shaft ends at this point are connected by a solid coupling whose flanges are integral with the shaft. A flexible pin-type coupling connects the generator with the low-pressure spindle correcting any misalinement and also serving to cushion the effect of any heavy short circuits should they occur. In addition to these main bearings, a Kingsbury double-thrust bearing is located at the governor end of the high-pressure cylinder and just outside the main bearing in order to correct shaft misalinement and unbalanced end-thrust. All main bearings are supported on the bedplate, which is of the same length as the unit with the exception that there is no section under the low-pressure turbine. Instead this element is supported by heavy lugs cast as a part of the lower half of the turbine casing and supported at four points by upraised sections of bedplate. These so-called "chairs" are situated two at either end of the turbine and near the sides of the bedplate.

The cast-steel high-pressure turbine is of a pure reaction-type and single-flow design. Steam is admitted first through a combination hand and automatic throttle valve at about 200 lb. gage pressure and 200 deg. F. superheat to the primary valve. These two valves together with steam strainer are spring-supported on the front side of the turbine. The primary valve admits steam direct into the first section of reaction blading and the steam is expanded through all the rows of the exhaust. The primary valve carries all loads up to 25,000 kw. Between 25,000 kw. and 30,000 kw. a secondary valve opens and admits steam to a lower section of blading. At 30,000 kw. and up to the maximum capacity of the unit a tertiary valve opens, by passing several rows of blading and admitting steam direct to an intermediate stage. The two latter valves are located on the top of the high-pressure cylinder both from a standpoint of convenience and to secure the shortest possible pipe connections.

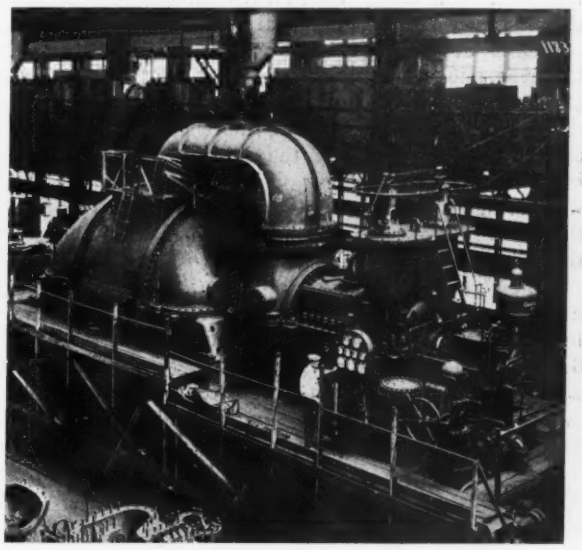


FIG. 1. THE 35,000-KW. UNIT IN COURSE OF ERECTION

The operation of these valves is accomplished by an oil relay system under control of a heavy but sensitive fly-ball type governor. This governor, as the load varies and tends to cause a change in speed, by a linkage system, acts upon a pilot valve which controls the admission of high-pressure oil to either side of a piston. Attached to this piston is a system of levers which control the valve positions. The linkages controlling the secondary and tertiary valves are given some lost motion so that each valve operates in series when the preceding one has reached its maximum position. The whole system is given a slight oscillating motion so as to overcome any sluggishness of action.

The oil in this system, as well as the oil delivered to the bearings, is supplied by a double reciprocating-pump located at the extreme end of the high-pressure turbine and driven by the turbine rotor. One side of

this pump discharges oil at 5 lb. pressure to the bearings and the other side discharges oil at 60 lb. pressure for the relay system. The unit has its own complete oiling system, having, in addition to the pump, a reservoir, cooler and strainer. Oil circulation is about 150 gal. per minute.

From the exhaust of the high-pressure turbine, the steam is brought to the cast-iron pressure element by an overhead receiver pipe at approximately 28 lb. absolute pressure and a temperature of 252 deg. F. This turbine is double-flow type, in which the steam is brought to the middle section of the spindle and expanded both ways through pure reaction-type blading to a 29-in. vacuum. It differs from two previously installed tandem compound 60-cycle units of the same capacity in that the exhaust of the low-pressure element terminates in a single opening.

The other two units had two exhaust openings and each turbine was served by two 28,000-sq. ft. surface condensers. This unit is served by a single 56,000-sq. ft. surface condenser built by the same company. It is installed crosswise to the turbine and the steam inlet is connected directly to the turbine exhaust, no expansion joint being used. Instead, the allowance for expansion is taken care of by helical springs supporting the condenser at four equal points. The condenser is of the type known as "two-pass radial flow." The nest of tubes is non-concentric, with the shell allowing a steam belt all around the tubes, thus shortening the path, as well as the velocity of the entering steam. Water boxes are baffled in such a way as to cause the circulating water to flow in the middle section of tubes across to the other side of shell and back through the outer section of tubes and to discharge.

The circulating pump supplied with the condenser has a capacity of 60,000 gal. of water per minute pumping against a 20-ft. head. This pump is driven by a 650-hp. induction motor, this capacity being double the actual pump requirements so that continuous operation is assured. There are two sets of combined LeBlanc-type air and condensate pumps. These are installed in the pit beneath the condenser and driven by 140-hp. steam turbines. The condensate pumps will discharge 1200 gal. per minute against a 90-ft. head.

The generator is of the two-pole revolving field type and will carry 35,000 kv.a. load continuously without exceeding a total temperature rise of 150 deg. C. in either the armature or the field winding. The rotor itself is built up from rolled plates approximately made one

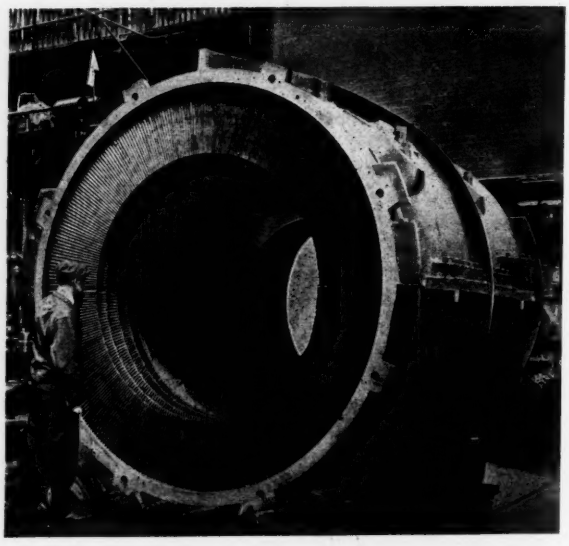


FIG. 3. THE STATOR OF THE LOW-PRESSURE TURBINE

solid piece by means of bolts passing through holes in each plate and bolted to the end pieces. The metal in the plates during the process of manufacture is worked in an axial direction, thus assuring good electrical properties.

The field winding consists of flat copper straps, mica insulated, and placed in the slots with the flat side parallel to the bottom of slot. Ventilation is secured by a number of air paths in parallel with the air gap.

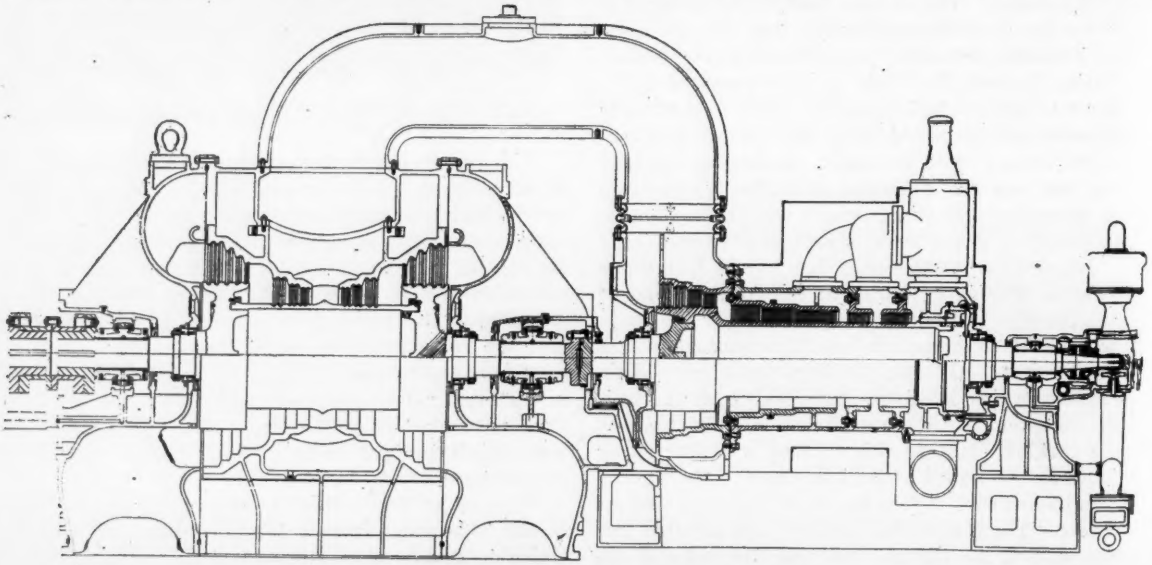


FIG. 2. CROSS SECTION VIEW OF THE NEW UNIT

The stator is made of cast iron and has an opening at the bottom for downward discharge of cooling air. Also provision is made for top discharge at some later date, if required. The armature coils are formed by several rectangular copper wires in parallel, insulated from one another, and the whole mica coil insulated in the embedded portion in the slots. The end connections are well braced to withstand short circuits.

Air is brought in at the end of the stator frame and passes through the end bells, practically half of the amount passing through holes in the stator punchings and toward the center where, by radial vent ducts, it is discharged through the punchings and flows in an annular direction to the downward discharge in the middle of the frame. The other half flows around the end connections and is free to pass both through the air gaps and the parallel ventilating ducts in the rotor toward the center and finally to the discharge outlet. The volume of air used under maximum load conditions is about 100,000 cu. ft. per minute. This air is furnished by an external blower driven by a 300-hp., 440-v., three phase, 25-cycle, 485-r.p.m. induction motor.

Electric Hoists in the Power Plant

NOTES ON THE APPLICATION OF THE ELECTRIC HOIST TO BOILER ROOM AND COAL-HANDLING INSTALLATIONS

COAL-HANDLING equipment is an indispensable part of practically every power plant burning coal of 50 tons or more daily, and of the modern plant is an integral part. In many of the smaller plants, however, there is a lack of such machinery, due, in a few cases, to indifference, but mainly on account of the first cost, which may seem excessive, or to the idea that the savings made possible by the use of such equipment would not be great enough to warrant its installation.

It is necessary, in order to effect the greatest possible savings, to install equipment best suited to the needs of the plant. It should be simple to operate, as a trained operator will not then be required, and consequently operating costs will be low. Mechanically, such machinery should be rugged enough to withstand possible abuse by inexperienced men, resulting in low repair costs.

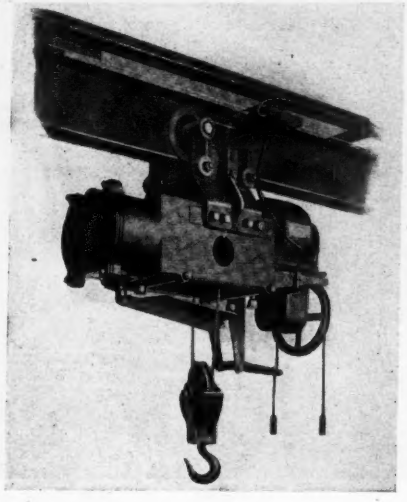


FIG. 1. A TYPICAL SMALL ELECTRIC HOIST

An electric hoist in one of the many forms available, operating on an overhead track, will often fill these requirements in the average small plant. One of the principal advantages of this type of equipment in connection with an existing plant is that it may be installed with a minimum of changes in the existing building or equipment. Practically the only expense besides the cost of the hoist and the necessary track and its supports, is for labor to install the latter.

TYPES OF ELECTRIC HOISTS

ELECTRIC hoists are available in sizes of from ½ to 10-ton capacity. The smaller sizes usually consist of an electric hoist mounted on a simple, powerful hand-pushed truck, while the larger sizes are provided with full electrical equipment controlled from a cab mounted on a trailing two- or four-wheel truck.

The most suitable sizes for the small boiler room are the ½- and one-ton machines, particularly where the haul is short. One of this type is shown in Fig. 1. This particular trolley was designed with a platform to accommodate any standard make of motor, making it possible to standardize plant motor equipment, where desired. Another unusually compact form of hoist, in which all working parts are protected by a symmetrical casing, is shown in Fig. 2. Both of these hoists are operated from the ground by means of hand lines.

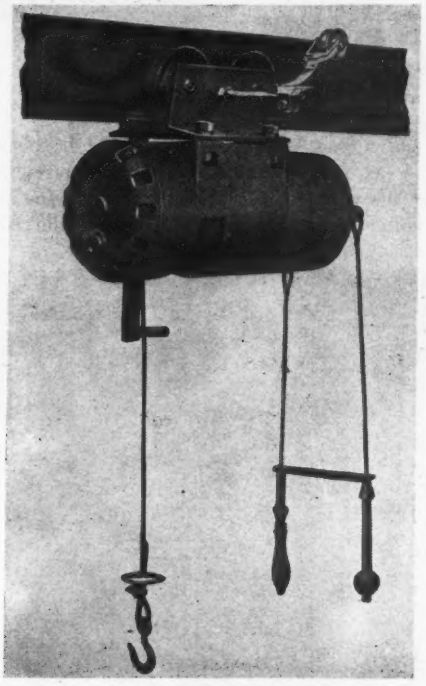


FIG. 2. A COMPACT TYPE OF HOIST

When the distance to be covered is comparatively great, as from an outside storage pile to the boiler room,

it is frequently advisable to provide a trolley of the type shown in Fig. 3. This consists of an electric hoist mounted on an electrically driven truck, operated from a cab suspended from a two-wheel trailing truck, pivoted to the main truck.

Planning the Track System

Convenience of handling should be considered when planning the track for an electric trolley coal handling

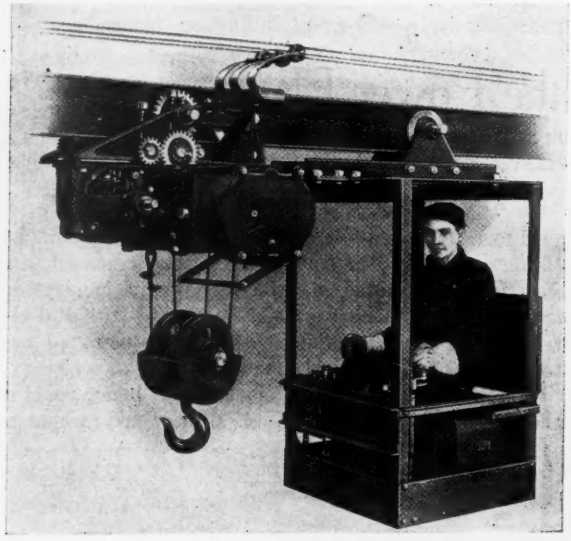


FIG. 3. CAB-DRIVEN ELECTRIC HOIST

system. Switches and branches should be provided to eliminate, as far as possible, the human element, by enabling the trolleys to reach any part of the coal storage or boiler room. In the hand-fired boiler room, effi-

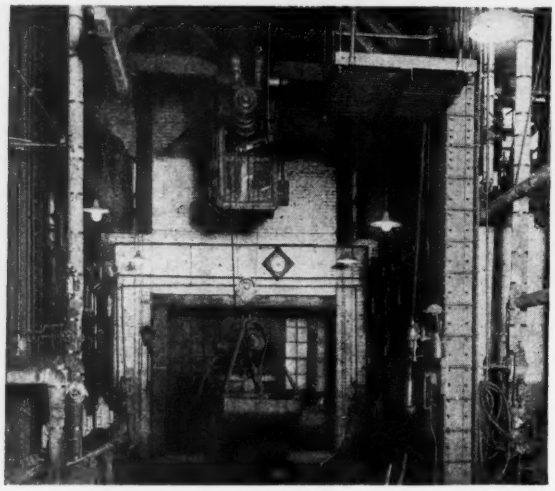


FIG. 4. ELECTRIC HOIST WITH ELECTRICALLY OPERATED GRAB BUCKET, SHOWING LOCATION OF TRACK IN BOILER ROOM

ciency requires that the coal shall be deposited at such points as will enable the fireman to get it into the furnace with a minimum of effort, and the track should be laid out with this point in mind. Figure 4, which shows a boiler room containing two rows of boilers, illustrates this point. Coal is deposited in the center of the firing aisle, where it is equally accessible to either row of boilers.

In stoker-fired plants, the coal can frequently be deposited directly in the stoker hopper. A view of an installation of vertical boilers equipped with dutch-oven type stokers, where this method is employed, is given in Fig. 5. The cleanliness of the firing aisle speaks for itself. In this case the track which is used for coal handling is also used for removing ashes from in front of the furnaces. The ability of this type of trolley to negotiate sharp curves is shown by the comparatively short-radius curve employed in this installation.

The layout of the outside trackage is of equal, if not greater, importance than in the boiler room, as it is in transporting coal from the car or storage bin to the boilers that the greatest expense is incurred. Provision

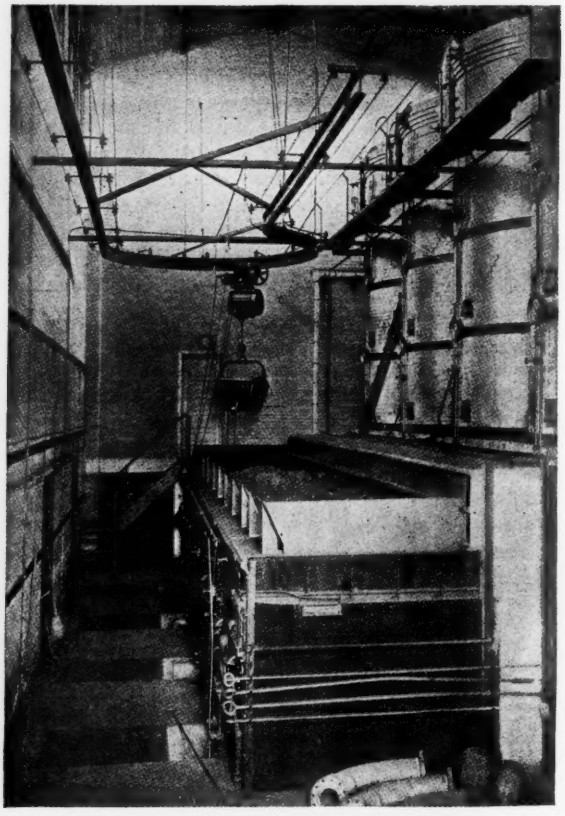


FIG. 5. ELECTRIC HOIST IN STOKER-FIRED BOILER INSTALLATION

for storage of some coal should be made in even the smallest plants, to eliminate demurrage charges for holding cars over the limit of time, and, even more important, under present conditions, to release needed cars for other work.

Trolley Tracks for a Small Plant

Probably the best arrangement for a small plant would be to have the outside track in the shape of a comparatively long oval parallel to the boiler house. One track should be erected over the center of the rail-

road track for unloading coal, which can be delivered either to the storage pile or bin under the other track, or to the boiler room direct. An elementary diagram of such a layout is given in Fig. 6. In unloading cars, the curve at the left provides communication with the storage bin, while the boiler room is connected with either the car or storage bin through the switch at the right. When a grab bucket is employed, a long, narrow bin is preferable to an open pile, as any part of the stock is then accessible to the grab without manual labor. Although there are other forms of track, the I-beam type is almost universal.

The size of the plant will determine to some extent whether an ordinary tilting bucket or a grab bucket is used. While the tilting bucket requires coal to be shoveled, it nevertheless saves much unnecessary handling of the coal. Where an independent grab bucket is to be employed, the choice is between the gravity and the electrically operated types. The gravity type, as its name indicates, opens by its own weight and that of the coal, when a catch is released, and closes when it comes in contact with the coal, and the operating mechanism has been lowered sufficiently to re-engage the catch. The electric type is provided with a motor and winding drum for opening and closing. An application of the electric type is shown in Fig. 4, in connection with a cab-operated trolley.

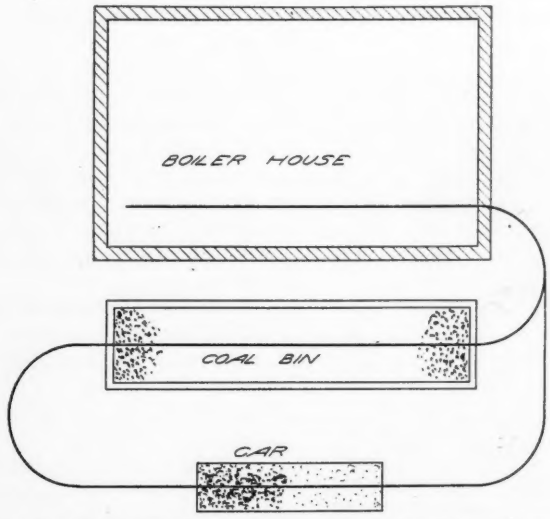


FIG. 6. ELEMENTARY DIAGRAM OF TRACK LAYOUT FOR SMALL PLANT

Cost of Operation

The cost of operation of an electric hoist is small. Unless used continually, the current cost is almost negligible, while labor cost is low, due to the fact that a highly skilled man is not required to operate such a hoist; in fact, one of the firemen could be employed part of the time on this work.

With cab-controlled electric hoist, equipped with a ¾-cu. yd. bucket, capable of handling 1000 lb. of coal at one time, it is possible for one man to convey about 15 tons of coal to the fireman and remove the ashes from the boiler house in about four hours, the time varying somewhat with the distance from the boiler house to the storage bin.

Another point which commends itself to the owner of the small industrial plant, particularly in providing an additional reason for installing coal-handling equipment, is that by providing additional tracks to other parts of the plant, the range of usefulness of an electric hoist can be greatly extended. The bucket can be removed and much of the heavy lifting and trucking can be done at a fraction of the cost with manual labor.

Removing Impeller Improves Centrifugal Pump

By L. W. Wyss

IT IS the duty of the station chief to keep his plant running 24 hr. a day and every day of the year. Therefore, he must not rest satisfied at just keeping his plant in good condition, but should analyze every piece of equipment with a view to improvement which will render more efficient and reliable operation.

At one well-loaded hydroelectric plant, two motor-driven two-stage centrifugal pumps were used to pump cooling water for the high-tension transformers. Only one pump was used at a time, but they were of rather poor design and the chief was always apprehensive about the one in operation while the other was dismantled for repairs. Some experimenting proved that with one impeller removed and the pumps running single-stage, they were still able to supply more than enough water for cooling purposes. Single-stage operation removed the disadvantage of poor design and the chief now has complete confidence in them.

Suction for these pumps is obtained through a pipe leading through the concrete structure to the forebay, and the chief did not care to take a chance on this suction pipe blocking with rubbish and shutting down his plant, so he has installed an auxiliary suction pipe with suitable valves leading from one of his turbine penstocks which is in readiness for that particular emergency.

We have often heard the expression: "One-half of the world does not know how the other half lives." No doubt the idea that it was intended to convey is: We think the other fellow is better off than we are.

Instead of allowing our minds to dwell upon such things, we should find out why the other fellow is better off—if he is—and whether it is due to our shortcomings. Then let us try to catch up. If we have good reasons to believe that such a thing is futile, then let us do the best we can; if we do that, we have done all that anybody can do. Having done that, let us make sure that we are doing everything in our power to prevent retrogression, and then live contented; for contentment, after all, is only a state of the mind.

Uncle Josh was a handy man about the power house yard. A gentleman passing asked him if they used steam turbines.

"Yes, sah, boss."

"What are they like, and how do they work, Uncle?"

"Well, dey am like a cylindah, and dey works jest like a little steam engine a runnin' wild."

GEORGE A. GOODENOUGH

MASTER OF THERMODYNAMICS AND POPULAR ENGINEERING INSTRUCTOR. BY CHARLES R. RICHARDS

HAVE you ever wondered how the big-brained men looked, who utilize for your purposes, the principles of thermodynamics, that branch of science dealing with the interconversion of heat and work? Their masterful ability to operate with complex thermodynamic formulas, filled with mysterious symbols, has placed at our disposal valuable information. Their steam tables, heat diagrams and experimental data have rendered valuable aid to the engineer in determining the limitations of his steam engine or turbine, gas engine or refrigeration machine. Their achievements have been of vast importance in engineering progress.

G. A. Goodenough

To have a full workable understanding of thermodynamics is a talent, but to possess the power of clearly explaining its principles to others is a mark of genius, a valuable requisite of an engineering instructor.

Twenty-two generations of engineering students at the University of Illinois have come under the inspiring and kindly influence of George Alfred Goodenough, Professor of Thermodynamics. Many graduates have testified to their appreciation of his teaching and friendly interest in their work as students, and in their careers since graduation. The affection and esteem in which he is held by these men should be an inspiration to other teachers, since it illustrates in a striking manner the opportunities for useful service which come to all educators.

Professor Goodenough's success as an engineering instructor is based upon thorough preparation in the subject which he teaches, and great enthusiasm in his presentation of the subject in the classroom. More, perhaps, than this, he is a man of the broadest human sympathies. In his relation with his students and with his colleagues, he is charitable of their opinions and considerate of their feelings. His judgment is always highly regarded, for he has the ability to present his ideas in a clear, logical, dispassionate and convincing manner which carries with it his sincerity and honesty of purpose. He is often able, by his keenly humorous presentation of his views, to relieve a situation which may have become tense as the result of differences of opinion in the debate of a committee or of the faculty. His disposition is as sunny as a June morning.

Professor Goodenough is regarded as the ideal type of faculty man. He is interested in his work and in his students. Although no cup-winning athlete himself he has always been intensely interested in college sports, and he has done much to develop the students' ideals concerning the ethics of clean competition. As a member of the Illini Publishing Co., he has helped develop a high standard in college publications. Last but not least, Professor Goodenough is a member of the University Committee on discipline for men, a position for which he is peculiarly well qualified on account of his ability to consider with calm deliberation the cases brought before this committee.

Professor Goodenough was born at Davison, Mich., on May 3, 1868. He became a student in Mechanical Engineering at the Michigan Agricultural College in 1887 and received the degree of bachelor of science from that institution in 1891. In 1891 and 1892 he took graduate work at the University of Michigan and in 1900 he received the professional degree of Mechanical Engineer from the University of Illinois.

Following his graduation from the Michigan Agricultural College, he remained there for two years as instructor in mechanics. He was connected with the International Correspondence Schools of Scranton, Pa.,

from 1893-95, preparing text-books in various branches of engineering.

Later he became instructor in mechanical engineering at the University of Illinois, filling this position from 1895-97, after which he returned to the International Correspondence Schools in an editorial position which he held for two years. In 1899 he was prevailed upon to return to the University of Illinois as Assistant Professor of Mechanical Engineering. In 1906 he was appointed Associate Professor of Mechanical Engineering and in 1911 he became Professor of Thermodynamics. To fill a vacancy in 1909, Professor Goodenough served for two years as acting head of the Department of Mechanical Engineering.

He is a member of several college and honorary engineering societies and also a member of the Society for the Promotion of Engineering Education.

In addition to his success as a teacher, he is recognized as one of the most productive contributors to the literature of engineering. His chief interests have been in the theoretical problems of engineering science, and he has devoted much of his time to the study of higher mathematics, mechanics and thermodynamics. He is one of the foremost authorities in thermodynamics in America, and he has unusual ability in presenting this difficult subject in such a clear logical manner that even the student of average ability may acquire considerable enthusiasm for the work.

In 1908, in collaboration with Dr. E. J. Townsend, Professor Goodenough published a book entitled "First Course in Calculus" and two years later he published a book on "Essentials of Calculus." In 1911, his book on "Principles of Thermodynamics" was published, and it has since come to be extensively used in the better technical schools of America. In 1915, his book on "Properties of Steam and Ammonia" was published and it is now regarded as one of the standards for use in computation involved in steam engineering and in refrigeration.

In addition to the books which Professor Goodenough has published, he has contributed, collaboratively, a number of excellent bulletins to the list of those issued by the Illinois Engineering Experiment Station. Among these are: "An Extension of the Dewey Decimal System of Classification Applied to Engineering Industries," "The Strength of Chain Links" and "The Properties of Saturated and Superheated Ammonia Vapor." In this last bulletin, for the first time, there were brought together all of the existing data concerning the properties of ammonia vapor. After a careful analysis of these properties and of the application of thermodynamic principles, it became possible to devise formulas for the calculation of the several essential properties of the saturated and superheated vapor of ammonia, from which were calculated tables which are now very largely used by engineers who have occasion to deal with problems in mechanical refrigeration. In 1914, he prepared a bulletin entitled "Thermal Properties of Steam," presenting a careful investigation of the existing experimental data regarding the properties of water and steam.

Professor Goodenough has also contributed to a number of standard engineering reference books. Recently he prepared a section on Thermodynamics for the "Mechanical Engineers' Handbook." In addition to the books, bulletins and articles specifically mentioned, he has contributed numerous scientific papers to the proceedings of engineering societies and to the technical press.

His hours are not wholly confined, however, to reflections upon the possibilities of the Carnot cycle, temperature-entropy diagrams, and steam tables. He enjoys reading Dickens, Thackeray and Scott, whose literature is a popular part of his large private library, and he is fond of music. In summer he is frequently seen on the golf course at Urbana, converting heat energy into long drives up to the green and displaying true mathematical precision in his putting. For a number of years he has been matching his skill with that of his former student and present colleague, Professor Leutwiler, at playing skat.

A New Motor Gas

MOTOR gas at 5 cents a gallon is the promise of P. J. Chasler, of Bay Ridge, New York, who has invented a new kind of yeast, with which, it is claimed, denatured alcohol can be produced to sell at a profit at that price. The inventor does not propose to manufacture alcohol, but to sell the yeast, to individuals or firms, to make fuel for their own use or for commercial purposes. With this yeast, alcohol can be made from any vegetable matter containing starch, sugar or cellulose.

Denatured alcohol produced by the new method is said to be superior to gasoline in the following points:

It gives 75 per cent more miles than gasoline, when used in an automobile.

It does not carbonize.

There is no smoke or poisonous gas.

It contains no acid or corrosive.

It burns with a white flame that can be extinguished with water.

It ignites instantly, with one turn of the motor, in hot or cold weather.

It does not interfere with lubrication.

It lengthens the life of the motor.

It is not dangerous to handle, and is non-explosive in the open air.

The color of the flame, white, differs from that of alcohol produced in the ordinary way, and leads one to believe that there is considerable organic matter present in the new liquid.

If a liquid fuel is produced at anywhere near 5 cents a gallon, it will have a much wider field of application than the gasoline automobile, and if it has all the good qualities of alcohol will help to bring alcohol and gasoline prices back to a reasonable figure.

U. S. CIVIL SERVICE COMMISSION announces an examination June 8, for computer and designer on heating and ventilating work, a vacancy in the Bureau of Mines for duty at Pittsburgh, Pa., at $1440 a year, and vacancies in positions requiring similar qualifications throughout the United States, at this or higher or lower salaries. Competitors will be rated on drawing of heating and ventilating plant, training and experience and must have reached their twentieth birthday on the date of the examination. Apply for Form 1312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

Heat Insulation

POINTERS ON THE SELECTION AND INSTALLATION OF HEAT INSULATING MATERIALS

HEAT INSULATION has always been an important factor affecting the operating economy of power plants and heating systems. Today, however, when we are beginning to realize that our supply of fuel is not inexhaustible and when the consumption of fuel almost exceeds the production, conservation of heat assumes a more important aspect in the engineering field that ever before. With the present high cost of fuel and labor, the value of the B.t.u. has increased to such an extent that it becomes imperative to reduce the heat losses in the power plant to a minimum.

In the selection of a suitable heat insulation for a particular purpose, the governing factor in most cases will be the economy that can be obtained by its use. The economy obtained by insulation naturally depends on the losses that would occur if it were not used, and the nature and relative values of these should be clearly understood.

The value of the heat lost from surfaces directly heated by the furnace is equal to the value of the fuel burnt to produce it, plus the value of the labor to handle it and its ashes, and a proportion of the investment charges, as the loss of this heat will require a larger installation.

The value of the heat lost in breechings and smoke stacks is small, and is covered by the increased size of these necessary to give the same draft at the lowered efficiency.

To determine the value of the heat lost from steam heated surfaces, the process becomes more complex. The cost of each pound of steam includes the coal cost divided by the boiler efficiency, and the proportional cost of all boiler house labor, supplies and overhead charges.

The value, then of the heat lost from a steam line or other steam heated surface is greater than the same amount of heat lost from a furnace wall, and the necessity for more efficiently insulating these surfaces is thus made evident. Furthermore, the result of losing heat from steam must be considered. If superheated steam is used, its temperature is lowered, causing the necessity of a larger boiler investment to compensate for the drop. Where the steam is saturated, the loss of heat will cause some of the steam to be condensed. This condensate contains heat which, if returned to the boiler, will be saved. If it is not returned to the boiler, it will all be lost, and this amount must be added to the heat actually dissipated from the pipes, etc. The actual monetary loss from the steam pipe losses is greater than the value of the actual heat dissipated from them.

KINDS OF HEAT INSULATION

HEAT INSULATION is made in numerous forms and shapes for almost any purpose, and the manufacturers can furnish ample data and information to satisfy the needs of any particular case. The essential element which forms the basis of a great many of them is magnesia. The basic carbonate of magnesia is a very light pure white crystalline material containing a great number of microscopic air spaces separated by the crystals and is thus one of the best heat insulators in existence. Alone, this material lacks the necessary strength required to resist shipping and handling, so asbestos fiber is usually added for reinforcement. The correct proportions are about 85 per cent of magnesia to about 15 per cent of asbestos fiber.

Asbestos itself is an admirable heat insulator. It is manufactured into many forms, and its fibrous nature renders it suitable for weaving into heat-resisting fabrics and for making into paper. These fabrics and papers can in turn be formed into heat insulators and fireproofings.

Air, when properly confined in volumes so small that heat will not be carried by it through convection, is an excellent heat insulator. Asbestos fiber offers a very suitable material for building up a mass of small air spaces, and many insulating materials are made of asbestos one way or another, in which the insulation value is due to the air caught among the fibers of the asbestos.

A short list of the more common types of heat insulations and their uses is given below.

85% Magnesia	For hot water heating systems Low and high pressure, and high temperature steam lines Boiler settings
85% Magnesia blocks	Boilers Feed water heaters, etc. High temperature valves and fittings
Asbestos felt	Boiler doors Fire doors Clean-outs, etc.
Asbestos cement	Hot water heating systems Hot air heating systems Low pressure steam heating systems
Laminated asbestos paper	Steam pipes subject to vibrations and hard knocks
Air cell asbestos paper	Hot air heating systems
Air cell asbestos blocks and pipe covering	Low pressure steam heat
Asbestos blocks and lagging	Boilers or surfaces where insulation must be taken down often Gas producer lines Ovens Furnaces
Vitrified asbestos stack linings	Stack linings Breechings, inside surface
Sil-o-cel	Boiler settings Steam pipe covering Gas producer lines
Wool felt	Hot water lines Cold water pipes—to prevent freezing

ECONOMIC THICKNESS OF INSULATION

HAVING SELECTED the proper form of heat insulation for a certain purpose, the next thing to determine is the thicknesses to be used. These are fixed by determining what is sometimes called the economic thickness. The money saving per year can be calculated for any thickness, as can also the yearly charge due to insulation cost, this consisting of the sum of the interest, the depreciation, and the repair charges. As each small addition is made to the thickness, there will be small increases in the savings and in the investment charge. It is evidently economical to add that increase in thickness as long as the savings continue to increase at a faster rate than the investment. If the reverse occurs, it is, of course, not economical to add it. That thickness at which they have the same rate of increase is the economical one.

Mathematically, it is the thickness at which the first differentials of the savings and investment charges are equal.

Insulation of the same thickness is less effective on a curved surface than on a flat surface, and the benefit obtained from the use of increased thickness is also comparatively less on a curved surface, due to the increased area through which the heat passes and the increased area of the outside of the insulation from which the heat is transferred to the outside air. The smaller the pipe, the more pronounced is this effect. The cost of additional insulation also increases more rapidly with the smaller sizes of pipe than with the larger sizes. The economic thickness is thus less for smaller piping, due to these two factors of decreased effectiveness and increased cost.

Sometimes there is a question as to whether insulation should be applied in one or two layers. Usually, with good workmanship, the extra expense is not justified, as the only gain with the two layers is that openings between joints are less likely to occur.

The saving accomplished by the use of the economic thickness of pipe covering is comparatively very great. With 85 per cent magnesia of economic thickness, the saving will in most cases repay the original cost of the installation in less than a year, and under constant operation at high temperatures where great thicknesses are called for, the saving will often pay for the installation in as short a time as two months.

The rule for economic thickness, as described, must be distinguished from the return on the investment represented by insulation. The cost of insulating material and the return must be compared on the same basis, either the total charges against the annual savings, or original cost against capitalized savings. To compare annual charges against annual savings would seem to be the easiest way, the annual charges being interest, repairs and sinking fund.

The accompanying diagram will give the proper thick-

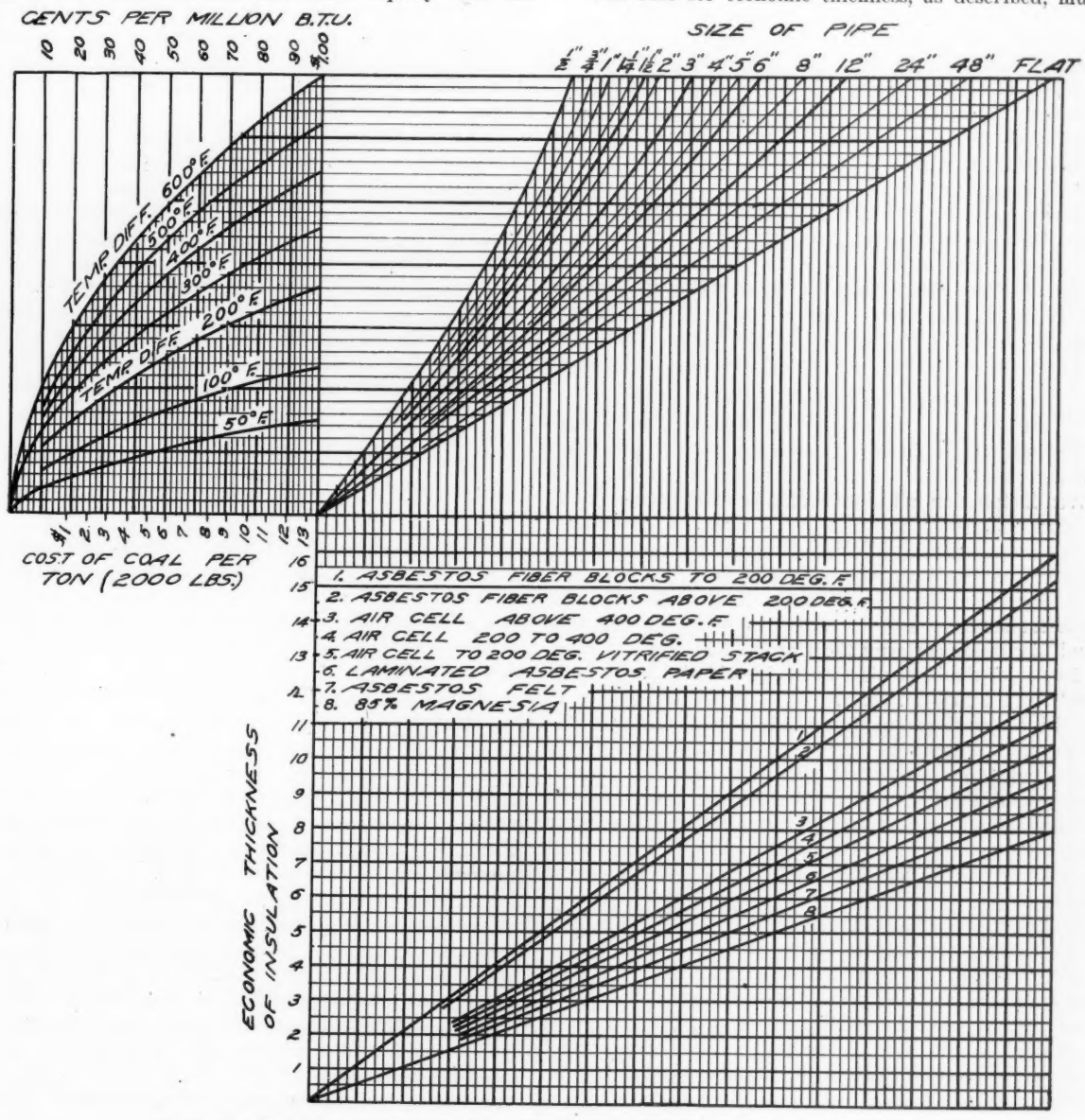

CENTS PER MILLION B.T.U.
10 20 30 40 50 60 70 80 90 100
SIZE OF PIPE
1" 1¼" 1½" 2" 3" 4" 5" 6" 8" 12" 24" 48" FLAT
TEMP. DIFF. 600° F.
500° F.
400° F.
300° F.
200° F.
100° F.
50° F.
$1 2 3 4 5 6 7 8 9 10 11 12 13
COST OF COAL PER TON (2000 LBS.)
1. ASBESTOS FIBER BLOCKS TO 200 DEG. F.
2. ASBESTOS FIBER BLOCKS ABOVE 200 DEG. F.
3. AIR CELL ABOVE 400 DEG. F.
4. AIR CELL 200 TO 400 DEG.
5. AIR CELL TO 200 DEG. VITRIFIED STACK
6. LAMINATED ASBESTOS PAPER
7. ASBESTOS FELT
8. 85% MAGNESIA
ECONOMIC THICKNESS OF INSULATION
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

DIAGRAM FOR FINDING THE CORRECT THICKNESS OF VARIOUS INSULATING MATERIALS

ness for a number of different materials. The charge against the investment is assumed as 13 per cent, consisting of 6 per cent interest, 5 per cent to the sinking fund (approximately 15 yr.) and 2 per cent for repairs. It must be understood, however, that while the basis of the economic thickness is that additional materials will just pay out in 15 yr., the total material which has been applied to bring the thickness up to this economic point will pay out many times in 15 yr.

The method of using the diagram is as follows:

Follow the vertical line of the cost of heat to its intersection with the curve of temperature difference, carry over horizontally to the curve of pipe size, then vertically down to the curve of desired material and, finally, along the horizontal line to the scale of proper thickness at the left.

The loss from a small pipe, due to the increased curvature as stated before, per square foot of pipe surface will be greater than on a large one for the same thickness of insulation. It may very well be the case, however, that there will be a greater saving in the case of the small pipe than in the case of a large pipe per square foot of pipe surface, as the losses from bare surface are so much greater in the case of small pipe.

Method of Applying Insulation

The method of installing heat insulation is comparatively simple, especially in the case of pipe covering. In determining the amount of material necessary for a given installation, all pipes should be carefully measured as to length and size and a record made of the number of each size of fittings. As pipe covering usually comes in sections 3 ft. long, sufficient must be ordered so that the required amount may be made up from 3-ft. lengths.

Flat surfaces to be covered can easily be measured and blocks for covering them ordered in terms of area. The size of the blocks is about 6 in. wide by 36 in. long, and from 1 to 3 in. thick.

Pipe coverings are furnished in sections to fit the pipe split lengthwise, having a canvas covering with sufficient flap so that when this is pasted down, the covering will be held together. Sheet metal bands are furnished with a loop at one end, so that they are easily fastened around the pipe covering by simply introducing the other end of the band in the loop and bending it back.

Blocks are usually fastened to boiler surfaces, etc., by soft iron wire wrapped outside of the blocks and fastened together. Ends of boilers are covered in the same way, and wires are run from the wire nearest the end of the circular portion over the blocks on the end in such a way as to hold them securely. An insulating cement is usually applied over the blocks and wire and sometimes canvas is pasted over this.

Fittings, such as valves, tees, ells, flange-joints, etc., should be covered with cement to the thickness of the adjacent pipe covering.

In applying insulation cements, use two or three coats, permitting each coat to dry out before the next is applied, and if it is possible to have heat in the line during this time, the cement will dry out more quickly and will probably stick better. The first coat should be compressed as little as possible so that it will be light and porous, thus giving the material the greatest insulating value possible, as the insulation value will depend upon the amount of confined air held in the mass.

Hot air heating systems are usually insulated with asbestos air cell paper, which consists of two sheets of asbestos paper, one flat and the other corrugated, cemented together. This is wrapped around the pipes with the corrugations on the inside, to a thickness of one or two layers. The material is then fastened in place by tying it with iron wire or by the use of bands especially made for the purpose.

Where coverings are used on pipes or other surfaces exposed to the weather or dampness, the covering should be coated with an asphaltum varnish, which not only renders them impervious to moisture, but also adds to their efficiency by hermetically sealing all joints and seams.

Vitrified air cell blocks are used for stack linings mostly, and their use will obviate entirely, or nearly so, the corrosion of the steel stacks due to acid fumes and will tend to preserve the paint on the outside of the stack. There are two methods of applying this lining. First, by the use of bolts through the lining and the stack, the bolt heads on the inside being countersunk in the lining and the hole filled with a special retort cement. Second, by the use of angle iron rings 3 ft. apart fastened to the inside of the stack sheet, through the standing legs of which are drilled holes at about 6-in. intervals. Double-pointed pins thrust through these holes will hold the lining blocks in position. The interstices are then filled with cement to protect the angles. The first method is usually used.

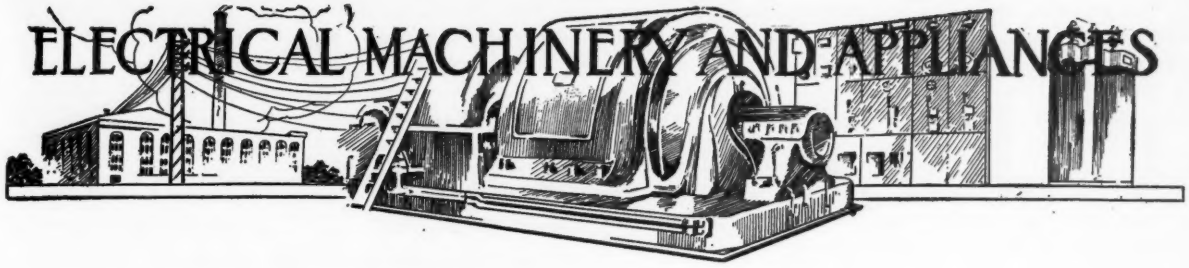
Every successful administrator must, among other gifts, possess two fundamental qualifications for leadership: he must have the ability to select the men best fitted for the work assigned to them, and the power so to co-ordinate the activities of the men selected that they may function as an effective unit.

An efficient executive will have his own definite policy by which his subordinates will be guided, but to them he will leave the details of execution. He must have an instinctive grasp of the situation as a whole, and know by intuition if these subordinates are harmoniously working out his general plan. He cannot, without waste of valuable time, himself attend to details, but he must, subconsciously as it were, be aware of the efficiency and faithfulness of each one working under him.

An administrator facing a multiplicity of important problems cannot hope to know more than his assistants about each one of their specialties; presupposing, of course, that these advisers have been selected in a sincere effort to obtain the most competent men available.

The successful executive must seek and duly consider the opinions of his subordinates, and of men who are experts on the subjects under discussion. Then, and then only, should he begin forming his own conclusions. This is the judicial method—the truly democratic one.—Gen. Leonard Wood, in the Outlook.

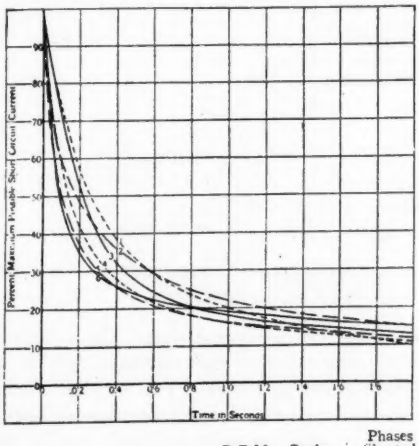
A cement for patching cast iron may be made of 16 oz. of finely pulverized cast-iron borings, 2 oz. sal ammoniac, 1 oz. sulphur. Mix well and keep dry. To use, take one part of the mixture to 10 parts cast-iron borings or filings and add enough water to make a stiff paste and calk it into the crack or hole to be repaired and let it set for 24 hr.



Protective Relays---II

THEIR FUNCTIONS AS APPLIED TO MOTORS AND TRANSFORMERS. BY VICTOR H. TODD

IN the early days of electric service, protection of motors and transformers was accomplished by ordinary fuses, which automatically disconnected the apparatus when the current became excessive. Even today, fuses cannot be exceeded for reliability on heavy overloads. It was soon realized that there were conditions of overload which the fuse did not take care of adequately, and besides, the fuse was not at all accurate or selective in its action and was quite expensive. For this reason the circuit breaker was developed and, while



				R.P.M.	Cycles	Phases Shorted
1	15 800	K.v.a.	Turbo	1500	25	3
2	20 000	K.v.a.	Turbo	1800	60	1
5	19 000	K.v.a.	Turbo	1875	62.5	1
3	12 000	K.v.a.	Alternator	116	25	3
4	6 600	K.v.a.	Alternator	375	25	3
6	15 000	K.v.a.	Alternator	375	50	3

FIG. 9. CURRENT DECREASE ON UNSYMMETRICAL SHORT CIRCUITS

it was a great improvement, yet it possessed small "reasoning" or "thinking" power; that is, it was very little better than fuse in its selective action. This led to the protective relay, a small instrument actuated by the currents in the machines or wires and controlling the action of the breaker. The relay is so flexible in its various connections and so accurate and selective in its action that it is called the "brains" of an electric system.

While the principal use is on large generating systems and long distance transmission lines, which is beyond the scope of this discussion, yet the overload relay may be applied to motors and transformers and give protection and uninterrupted service that can be obtained in no other way.

Before describing the various methods of applying overload relays for protection, it is well to take up the following points:

1. How long can the overload exist?
2. What is the intensity of a "short circuit"?
3. What other effects accompany severe disturbances?
4. What must the relay do, and how close may it be set with safety?

The duration of an overload without damage depends entirely on the apparatus itself; that is, it may be sustained until the excessive heat starts to burn the insulation, or cause other effects which would lead to damaged insulation. Damage from overload is seldom caused

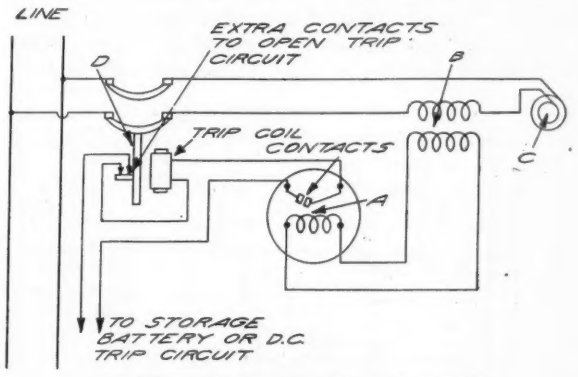


FIG. 10. SIMPLE OVERLOAD PROTECTION

except by heat, some exceptions being the breaking of shafts or the explosion of transformers. Modern design has, however, practically eliminated this danger.

Motors may often have their voltage reduced to zero for a second or so without being damaged or losing their load; they also may carry a heavy overload (about 50 per cent) without serious damage; but they must be protected so that they will be cut out of service should the load exceed 150 per cent for any length of time. If internal short circuits develop, causing excess current, they must be cut out very quickly to avoid serious burnouts.

Power transformers must also be protected against internal and external overloads in the same manner; in fact, an internal short in a large transformer might severely damage it in a few seconds, and as an internal short will seldom clear itself, its automatic isolation should be practically instantaneous.

Transmission lines, while seldom damaged themselves by overload, cause an excess current in the generators to which they are connected in case of short circuits, and there is no use in interrupting service if the line can be automatically sectionalized and isolated.

The overload which an alternator can stand depends entirely upon the alternator, as the characteristics of such machines vary over a wide range. The short-circuit current may be roughly calculated by observing the voltage drop between the two sections at normal load.

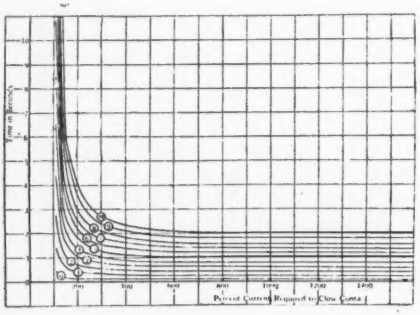


FIG. 11. TIME CURVES OF RELAY

The short circuit current at the first instant will equal the quotient obtained by dividing the normal voltage by the voltage drop and multiplying by the load current.

For example, if a certain load current causes a drop of 5 per cent in voltage, between a generating and a substation, the maximum short circuit current would be 20 times the load current. Practice has shown, however, that the short circuit currents are generally slightly

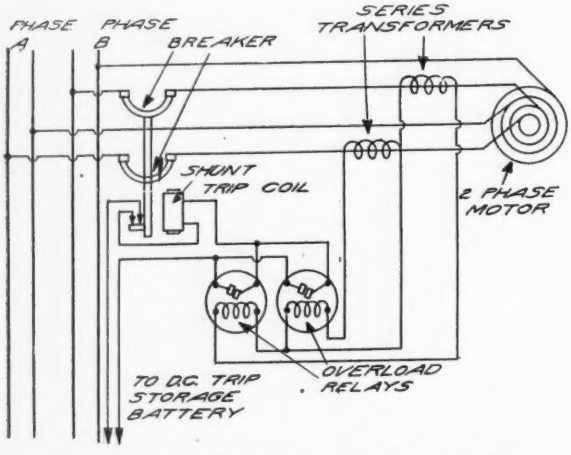


FIG. 12. SIMPLE PROTECTION ON TWO-PHASE CIRCUIT

less than this, particularly on lines having high inductance.

This current decreases very rapidly until a sustained short circuit current is reached, as will be seen by referring to Fig. 9. This curve does not mean that the maximum possible short circuit current is 100 per cent, but take as example an alternator which gives 12 times the normal load current on short circuit. This is 100 per cent; but this 12 times quickly decreases until the sustained current is about 12 per cent of 12 times, or 1.4 times the normal load.

Some alternators may deliver a sustained short circuit current of 2.5 or 3 times the full-load current. This rapid decrease of short circuit current is another important reason why a breaker should not trip out instantly. Its breaking capacity must be considerably greater to trip instantly than to trip when the current falls to its sustained value.

For these reasons the relay must be accurate, both initially and permanently, in load setting and time.

Protection of Motors

In its simplest application, the relay is arranged to carry a current proportional to the load current, and, upon the occurrence of excess current, close a circuit which trips or opens a circuit breaker. Figure 10 shows a relay, A, connected to the secondary of a series transformer, B. The primary is connected to carry the load current of motor, C, which is protected by breaker, D. Normally the relay contacts are open, but should motor,

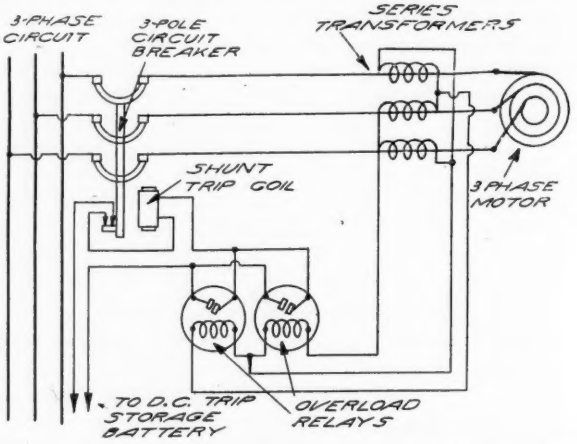


FIG. 13. SIMPLE OVERLOAD PROTECTION ON A THREE-PHASE CIRCUIT

C, be overloaded or develop a short, the excess current operates the relay, closes the contacts, which in turn complete the circuit to the trip coil of the breaker.

The time between the instant of overload on the instant of breaker opening may be easily set by the time lever on the relay—for instance, referring to the curves, Fig. 11, if the transformer delivers 5 amp. at full load, and Number 10 setting 5 amp. tap is used, then on 150 per cent load, it may take 5 or 6 sec. to trip, this being an indefinite part of the curve.

On 200 per cent of load (100 per cent overload), it will take 4 sec. to trip. If a shorter time was desired, setting Number 3 might be chosen and the same load would be tripped out in one second. Should the load be over 700 per cent, Number 10 setting would trip out in 2 sec.; Number 5 setting in 1 sec., and so on.

Suppose it was desired to have the motor trip on 120 per cent load (20 per cent overload); then the 4 amp. load tap would be chosen. At 120 per cent load the current would be 6 amp. (5 amp. $\times$ 120 per cent); but 6 amp. is 150 per cent load on the 4-amp. tap, so the relay would trip out in 6 sec. on Number 10 setting, and quicker on heavier overload and lower settings.

If a two-phase motor is to be protected, two relays and two transformers are necessary, unless an intercon-

nected system is used, when four transformers must be employed. One single, 4-pole circuit breaker would in this case be used and may be operated with one or two trip coils.

Figure 12 shows a two-phase protected motor circuit. If two trip coils were used, they might be connected in parallel, or connected separately to their respective relays. In any case, both phases should be opened.

Three-phase motors may be protected with two relays, but require three transformers for adequate protection. One trip coil is generally used, tripped by either relay, but the breaker must open all three lines. Figure 13 shows the connections. As in the case of the single phase, the time delay in tripping may be easily set by the time lever and load taps on the relay. Figure 14

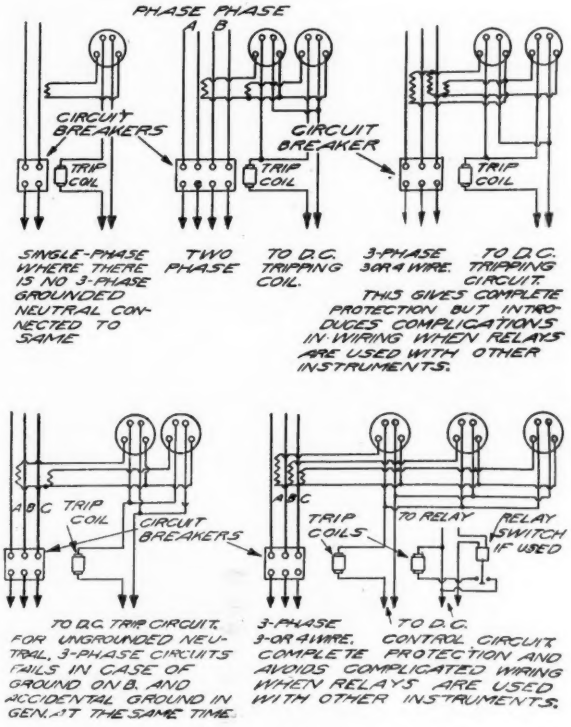

PHASE A
PHASE B
CIRCUIT BREAKERS
TRIP COIL
CIRCUIT BREAKER
TRIP COIL
TRIP COIL
SINGLE-PHASE WHERE THERE IS NO 3-PHASE GROUNDED NEUTRAL CONNECTED TO SAME
TWO PHASE
TO D.C. TRIPPING COIL.
3-PHASE 3 OR 4 WIRE.
TO D.C. TRIPPING CIRCUIT.
THIS GIVES COMPLETE PROTECTION BUT INTRODUCES COMPLICATIONS IN WIRING WHEN RELAYS ARE USED WITH OTHER INSTRUMENTS.
A B C
TRIP COIL
CIRCUIT BREAKERS
TO D.C. TRIP CIRCUIT. FOR UNGROUNDED NEUTRAL, 3-PHASE CIRCUITS FAILS IN CASE OF GROUND ON B, AND ACCIDENTAL GROUND IN GEN. AT THE SAME TIME.
A B C
TRIP COILS
TO RELAY
RELAY SWITCH IF USED
3-PHASE 3 OR 4 WIRE.
TO D.C. CONTROL CIRCUIT. COMPLETE PROTECTION AND AVOIDS COMPLICATED WIRING WHEN RELAYS ARE USED WITH OTHER INSTRUMENTS.

FIG. 14. TYPICAL RELAY CONNECTIONS FOR SINGLE, TWO AND THREE-PHASE CIRCUITS

shows typical diagrams of connections as supplied by the manufacturer.

Transformer Protection

If the relays are connected on the line side (generating side) of transformers which operate a load of motors, etc., they not only protect the load, but the transformers as well, opening the circuit in case of trouble in the transformers.

But the object is not only to protect but also to preserve the continuity of service, if possible. So, in important places, instead of using one set of large transformers, two or three sets of smaller transformers are used. For instance, instead of using a 1200-kv.a. transformer, three 400-kv.a. transformers might be used, connected in parallel or "banked." This bank has the same capacity as the big one; but if one set goes bad, the other two in the bank will assume the load; while, if the larger one is damaged, the service is interrupted until repairs or replacement can be made.

It is the function of the relay instantly to locate trouble in a transformer bank and cut out the defective unit without interruption to the load. The elementary principle of differential transformer-protection is shown in Fig. 15. A is a large power transformer having a 10 to 1 voltage ratio. Full load current is 100 amp. in the primary and 1000 amp. in the secondary. Cur-

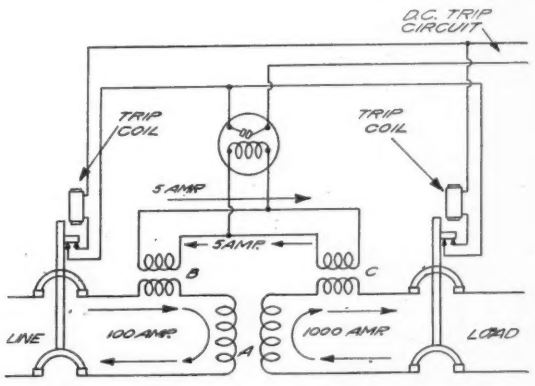


FIG. 15. DIFFERENTIAL TRANSFORMER PROTECTION

rent transformers are chosen for the primary and secondary, which give the same secondary current (generally 5 amp.). These are shown at B and C. The secondaries are connected in series so that at normal load and correct direction of power flow, a current will circulate in the secondaries and none in the relay, as there is as much tendency for flow in one direction as in the other.

As long as current flows away from the transformer in the same ratio as it flows into it (i. e., 1 to 10), there

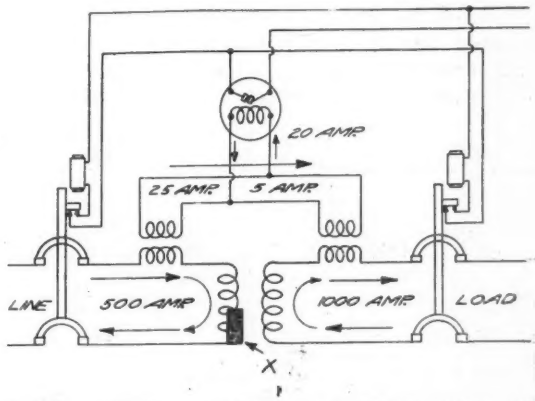


FIG. 16. SHOWING CURRENTS IN RELAY UPON SHORT CIRCUIT IN TRANSFORMER

can be no current in the relay; but consider Fig. 16. A short circuit has occurred in the winding at X and a heavy current, say, 500 amp., is flowing into the primary. The secondary current may not drop off much, but the transformer would soon be burned out.

Consider the current in the secondary of the series transformers. Five hundred amperes on a 100 to 5 transformer gives 25 amp. on the secondary. The other transformer (1000 to 5) will allow only 5 amp. to flow through it, so the extra 20 amp. must go somewhere.

Consequently, they flow through the relay, close the contacts, and trip both the breakers, effectually isolating the transformer.

Protection in Banks

If, however, there is another transformer operating in parallel with this and a short circuit occurs, the good

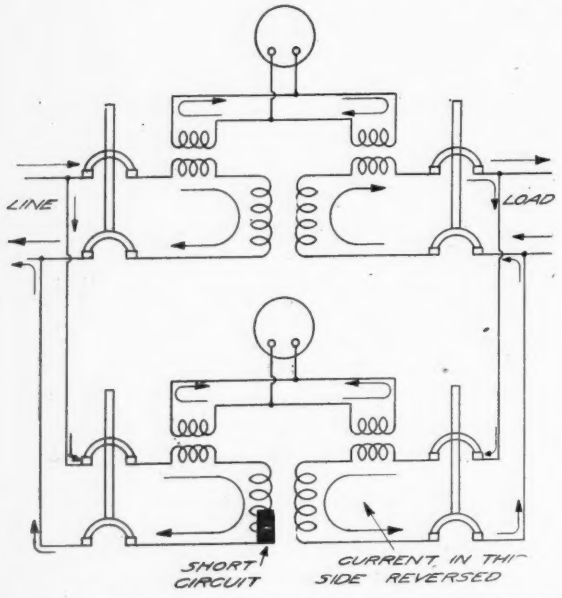


FIG. 17. TWO TRANSFORMERS IN PARALLEL; SHORT CIRCUIT IN ONE

transformer may feed the bad transformer from the secondary side and cause an actual reversal of power in the defective unit, that is, power feeds into the transformer from both sides, as will be readily seen by a consideration of the arrows denoting the direction of instantaneous current flow in Fig. 17.

This shows that the good transformer, as well as the defective one, becomes heavily overloaded and plainly

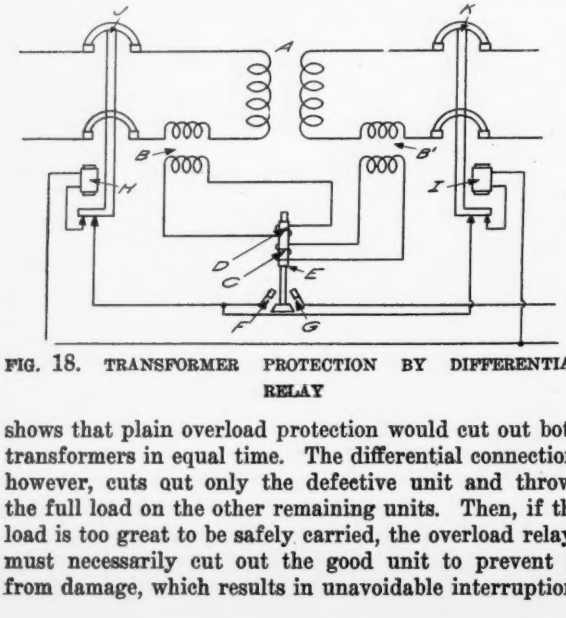


FIG. 18. TRANSFORMER PROTECTION BY DIFFERENTIAL RELAY

shows that plain overload protection would cut out both transformers in equal time. The differential connection, however, cuts out only the defective unit and throws the full load on the other remaining units. Then, if the load is too great to be safely carried, the overload relays must necessarily cut out the good unit to prevent it from damage, which results in unavoidable interruption. This would seldom occur as, for example, in our previous example of three transformers carrying a load of 1200 kv.a. If one goes bad, the others must each carry a load of 600 kv.a., which is only 50 per cent overload, and should be carried without difficulty. Should two transformers go bad, however, it is obvious that one transformer of 400 kv.a. could not carry a load of 1200 kv.a. and the relays have no alternative but to kick out the last remaining transformer to save it.

Other Differential Methods

Special relays, which accomplish the same protection, are sometimes built, in which the actuating winding is wound in two sections. These sections are connected to their respective current transformer secondaries and so arranged that the currents produce a bucking or zero flux, or magnetism on correct operation. When, however, the current in one winding exceeds the current in the other, the relay closes the contacts. Figure 18 shows a plunger type relay with a double winding, connected for differential protection. A is the large

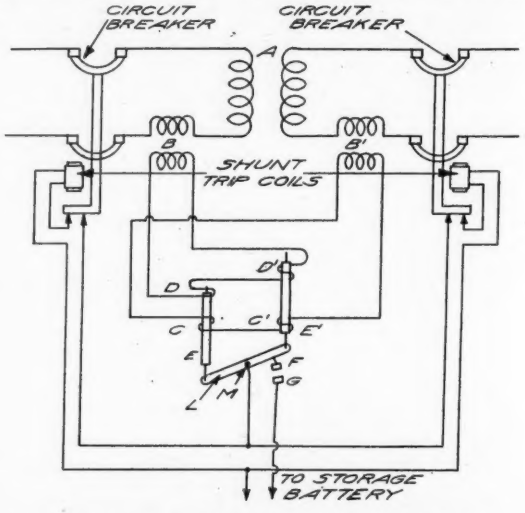


FIG. 19. DIAGRAM OF DOUBLE PLUNGER RELAY

power transformer arranged with series transformers B and C, which supply the relay windings D and C. Normally these currents oppose each other, producing no effect on the plunger E. But should one current reverse, due to a short circuit in A, both assist in raising plunger E, which closes contacts F and G, completing the circuit to trip coils H and I and opening breakers J and K.

Another type of relay uses two solenoids operating a pivoted lever which carries the contacts. This is shown diagrammatically in Fig. 19. The two plungers E and E′ work under the influence of the solenoids D C and D′ C′. Normally current from transformer B in winding D opposes current from transformer B′ in winding C resulting in no pull, while current in D′ assists that in C′, resulting in a maximum pull. Should the current in C and C′ reverse, then plunger E is pulled up and plunger E′, losing its attraction, falls down. This moves the lever L on its axis M, closing contacts F and G and tripping the breakers.

Polyphase

For the sake of clarity, all connections have been

shown single phase. Two phase requires two duplicates of the single phase.

In three-phase work, the transformers are generally worked in banks of 3-phase sets; that is, if one transformer in a set goes bad, the others in that same set go out also, leaving the other sets in the bank to carry the load. Each 3-phase set requires only two relays, but requires three series transformers on each side of the transformer.

Figure 20 shows a typical 3-phase differential protection connection for a 3-phase set.

Protecting 3-Phase Star-Delta Banks

A 3-phase bank of star-delta transformers, having a grounded neutral, attempt to maintain the voltage equal on all phases in case of overload or short circuit. As a result, in the case of a ground on the line, the transformers will supply current to the grounded wire, irrespective of whether these transformers are at substations or generating stations. In other words, if a small bank of transformers is connected to a large system and has its neutral grounded, it will be subjected to a short circuit every time there is a ground on the system. For this reason, small banks should have their neutrals isolated, not only because of the strain which frequent short circuits throw on them, but also on account of the frequent interruptions they entail.

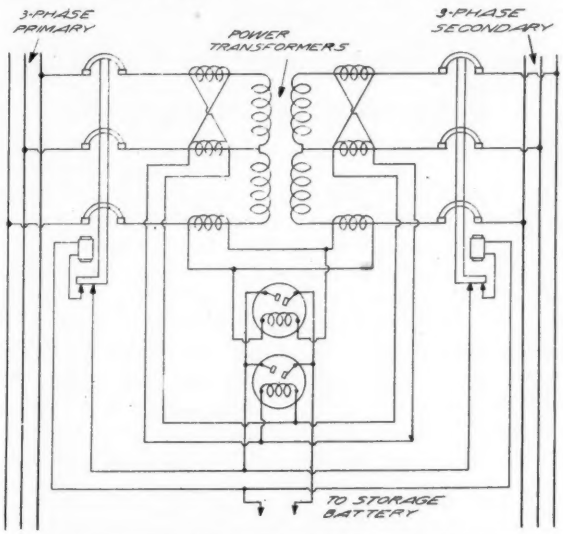


FIG. 20. DIFFERENTIAL PROTECTION OF TWO TRANSFORMERS ON THREE-PHASE CIRCUIT

The above argument applies principally to high-voltage systems, but it is necessary to consider the same conditions on low voltage 4-wire systems. Four-wire systems are generally used when there is a large amount of single-phase load to be distributed, and as a result the voltage on the three phases is liable to be unbalanced. When a bank of delta-star transformers is connected on to such a system, the question of grounding the neutral must be carefully considered. As a general rule, it is unsafe to make such a ground if the transformers are small, but if they are comparatively large, it may be advisable to utilize them to assist in maintaining balanced 3-phase voltage. This balancing is effected by drawing current from the high-voltage phase and supplying it to the low-voltage phase, and with a result that there is a flow of current in the neutral.

The possibility of burning out the transformers can be prevented by installing an overload relay in the neutral and connecting it so that it will sound an alarm or automatically open the neutral.

It frequently happens that star-delta transformers are connected to the main circuit through fuses and trouble is encountered when a single fuse opens. If the transformers are supplying a motor load and the neutral is ungrounded, the motor may run single phase and damage the motor. On the other hand, if the neutral is grounded, two of the transformers will carry all the load at a much lower power factor than normal. Unless there is a means of indicating a blown fuse, the transformers may carry the overload until burned out. A relay installed in the neutral and arranged to give an alarm seems to be the best means of protection when viewed from the various angles.

A Useful Electric Salt-Meter

By C. C. Brown

THE question of the "saltiness" or the amount of sodium-chloride, or salt, in return condensate from surface condensers has long been a bug-bear to power plant operators, both on land and at sea, the main objection to this salt being its effect upon boilers, fittings and joints, etc., throughout the system. Invariably when the salt content in the water becomes of a greater density than 300 or 400 grains per gallon of salt, tube trouble is going to commence. Besides this there is the factor of increased fuel consumption, for it is a well-known fact that the denser is a solution, the more heat it takes to boil it. As a consequence the returns from the condensers are closely watched and, if the test shows salt, the condensate is often turned to the sewer or overboard.

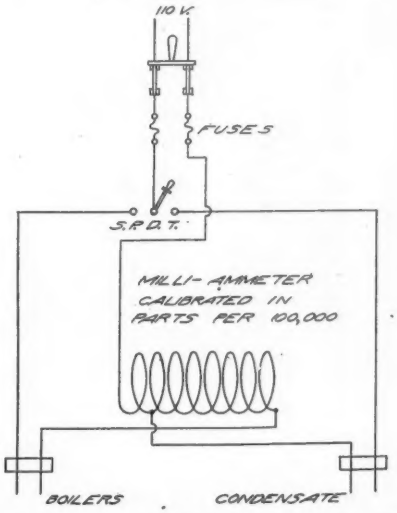


FIG. 1. DIAGRAM OF CONNECTIONS OF THE ELECTRIC SALT-METER

The question then becomes: When is the water too salty for use in the boilers, to what degree of salinity or saltiness can it be allowed to come before it is more

economical to discard it than to attempt to use it, and by what method are these things to be found out?

The method of ascertaining whether or not the return condensate is salty has been for years to take a sample of the water in question in a test tube, and with an eye-dropper to drop into it a few drops of silver nitrate. Should there be any sodium chloride or salt present, a white, cloudy precipitate will immediately be formed. The engineer on watch then knows immediately that his condenser tubes are leaking; but—he does not know how badly they are leaking, and he does not know how much salt is in his condensate, whether there is too much for its safe use in the boilers and if it should be turned overboard, or whether there exists just a trace of salt which would not do any particular damage to the boilers and equipment.

These facts were the reasons why the salt-meter was conceived and constructed. This instrument is an elec-

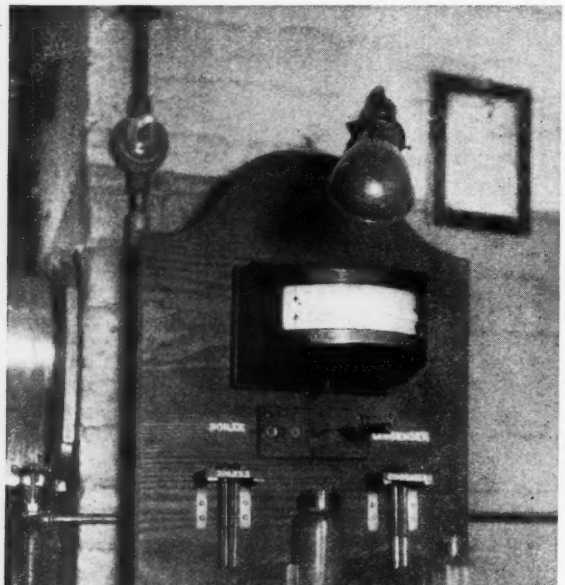


FIG. 2. SALT-METER SHOWN MOUNTED WITH AUXILIARY APPARATUS

trical device which depends for its action upon the fact that up to a given density any solution will conduct a current of electricity between two electrodes of given exposed area and spaced at a constant distance from one another. In other words, you put a sample of water across its terminals and the more salt in the water, the greater will be the current (within limits). The construction of the salt-meter is simple, as is shown in Fig. 1. It consists of a main switch, two fuses, a milli-ammeter (calibrated to read directly in grains per gallon of salt, or parts per hundred thousand), a single-pole double-throw knife switch, two sets of terminals, a measuring bottle and a test bottle. All of the foregoing are neatly mounted on a board, as shown. One pair of terminals is used for condensate and the salt is read from the upper scale, the other being used for boiler water and indicating on the lower scale.

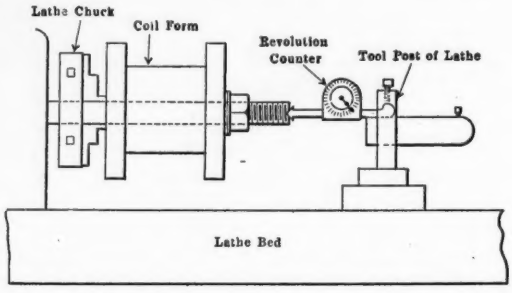
Operation of the instrument is likewise simple. If testing condensate, measure out a measure full of condensate in the small bottle. Fill it until it is running over. In this way, an equal amount of sample is assured. Next, pour your sample into the larger or testing bottle, throw the single-pole double-throw switch over on the "condensate" side, put the test bottle over the terminals with the mouth of it up against the bottom of the fiber bracket and read the amount of salt, either in grains per gallon or in parts per hundred thousand from the upper scale. If testing boiler water, the procedure is the same except that you use the other terminals and throw the switch to the "boilers" side, put the sample over the terminals and read the salt content on the boiler scale.

The whole apparatus is simple, durable, inexpensive and reliable. It is a non-patented, homemade, handy rig that any power plant operator can make up and which has given much to the several power plants where it has been used in San Francisco.

Novel Arrangement for Counting Turns when Winding Coils

By M. S. Clement

A UNIQUE arrangement for counting the number of turns of wire wound upon a field coil was recently used by the writer. The job called for the rewinding of a large field coil of circular cross-section, and it was necessary to have exactly 1085 turns on the coil. On account of the impracticability of having the workman count the turns as they are wound, the device shown in the accompanying drawing was used. The head of a 12-in. bolt was cut off, and the head end of the bolt was placed in a lathe chuck. The coil form was placed in position on the bolt and tightened in place



METHOD OF COUNTING NUMBER OF TURNS ON A FIELD COIL. COIL FORM IS MOUNTED IN LATHE CHUCK, WHILE COUNTER IS HELD IN TAIL POST

with a nut. Next a center was drilled into the threaded end of the bolt. A revolution counter was clamped into the tool post of the lathe so that the contact point fitted snugly into the center of the bolt. This arrangement registered every turn of the form, and made it possible to wind the coil with greater speed than would have been possible if it had been necessary for the workman to count each turn as it was made.—Electrical Record.

Italian industry is coming back after the war, and, where possible, hydroelectric power is made to do for coal.—Nation's Business.

Pipe Fitting Notes

DESCRIBING SOME EXAMPLES OF BAD PIPE FITTING AND HOW THEY WERE IMPROVED. BY H. A. JAHNKE

WE frequently have trouble with a leaky pipe joint and no matter how well the joints are made up they leak again in a short time. Where these conditions exist, it is best to locate the cause of the trouble, thereby avoiding delays and accidents. It may be that some part of the piping system has no way of expanding, thereby placing a strain at some joint, causing this either to leak or break.

CAUSE OF LEAKY PIPE JOINT

A MANUFACTURING plant found it necessary to replace its old boiler with a new one. In order not to shut down the plant during the time the new boiler was being installed, it was necessary to install it in another location than where the old one was. The owner was anxious to run the main steam pipe from the boiler to the engine in the cheapest possible way. The pipe was 6-in., extra heavy; and it was decided to arrange it as shown in Fig. 1, where it will be noticed that there is no way for the pipe to expand freely, with the results that after the pipe was in service a few weeks the joints A and B leaked

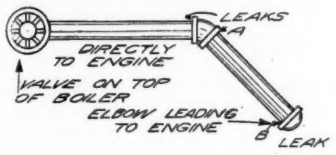


FIG. 1

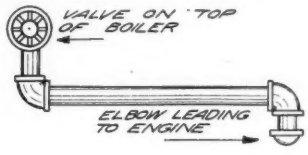


FIG. 2

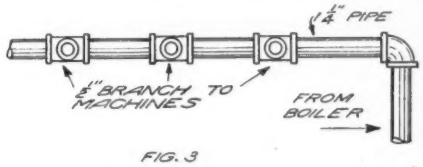


FIG. 3

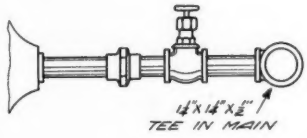


FIG. 4

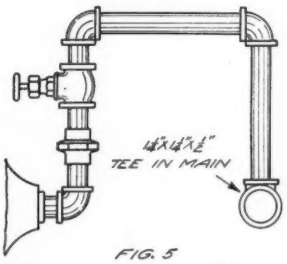


FIG. 5

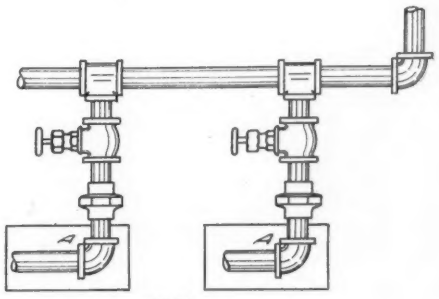


FIG. 6

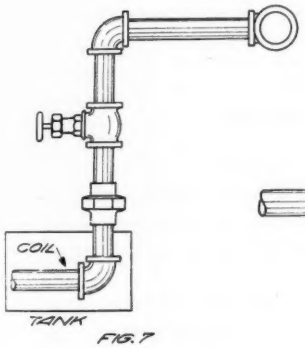


FIG. 7

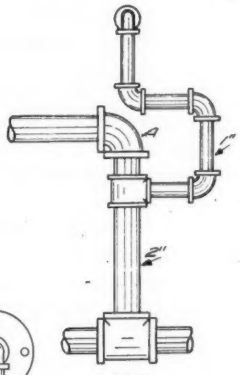


FIG. 8

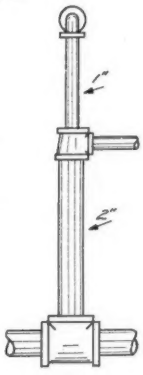


FIG. 9

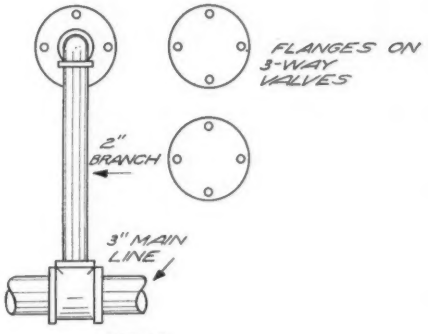


FIG. 10

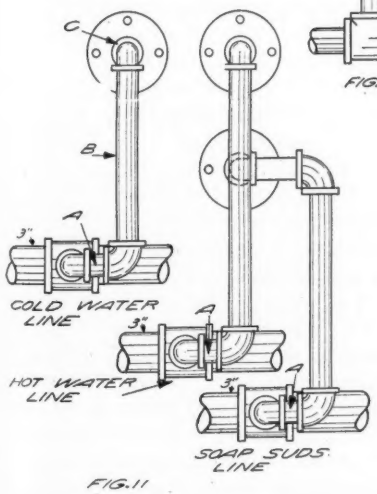


FIG. 11

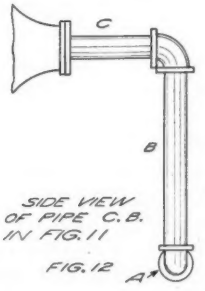


FIG. 12

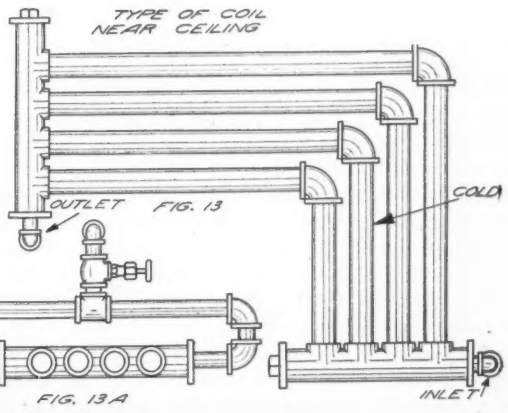


FIG. 13 FIG. 13A

EXAMPLES OF GOOD AND BAD PIPE FITTING

badly. These joints were remade a few times with no better results, making it necessary to rearrange the pipe as shown in Fig. 2, which allows for expansion. There was no more trouble with leaky joints after this change.

In another instance, a number of machines were set in a row as shown in Fig. 3, one main steam pipe furnishing steam to all. The branches leading from main to each machine were directly connected from the main to the machine as shown in Fig. 4. This arrangement allowed no expansion to the main line or branches and there was continuous trouble with the joints leaking or breaking. To remedy this trouble, the branches leading to the machines from the main line were arranged as shown in Fig. 5, permitting the pipes to expand without placing a strain on any of the joints.

In still another instance, live steam was used for heating water in a number of iron tanks placed in a row, the water being heated by means of pipe coils placed at the bottom of the tanks. The branches leading from the main steam pipe to the coils were connected as shown in Fig. 6. There was much trouble with leaky joints where the ½-in. pipes connect in to the coils at A, due to the fact that when steam was turned into the main steam line this would expand and cause a strain at the joints A. To remedy this trouble I had the pipes arranged as shown in Fig. 7, allowing the main pipe to expand more freely without placing a strain on any of the joints. This arrangement required more pipe and fittings but this extra expense was paid for many times by eliminating leakage and the breaking of joints as well as delays and repair work.

A Waste of Pipe Fittings

Frequently we notice a pipe job where more fittings such as ells, tees, etc., are used than necessary. I noticed a piece of work some time ago where a number of fittings were used unnecessarily, as is shown in Fig. 8. It will be noticed that a tee is placed in the 2-in. vertical pipe, then three ells are used to get the 1-in. line into position as wanted. In this case, three ells and one tee less would have been used by placing a reducing tee on the vertical pipe in place of the ell, A, then running the job as shown in Fig. 9. There was nothing to interfere with arranging the work in this way. This merely shows that some men use no judgment in laying out a piece of pipe work or they try to use as many pipe fittings as possible, thereby not only wasting pipe and fittings but time and labor as well.

A Peculiar Pipe Fitting Job

At one time I had the job of piping up a number of wash machines in a large steam laundry. Three main lines were run back of the wash machines, the cold and hot water and suds lines. It was necessary to run a branch line from each main to the three-way valve on the wash machine. We had decided to do the job as shown in Fig. 10. After piping up one machine, we found it took too much time as well as great care to have all branch pipes cut exactly the right length so as to make all flanges meet squarely or they would break in drawing them up, as they were of a very light type. In this way, much time and pipe were wasted in recutting the pipe to get them right; also, the pipe was too rigid and would allow no expansion of the two hot main lines as well as the two hot branches leading to the machines and there was the danger that, due to this fact, we would have leaks in some of the joints. We then decided to arrange the job as shown in Fig. 11, which made the work more simple, as in this way it was much easier to make the flange joints meet square by either lowering or raising pipe A and moving pipes C and B shown in Fig. 12. In doing the job this way, more fittings were used than in the other way, but I found that the work was done in much less time by avoiding the recutting; less pipe was also used. In this plan the main lines and branch pipe could expand either way without placing any strain on any of the joints.

Remedy for a Sluggish Steam Coil

All pipes on a large steam coil used for heating and located near a ceiling would not get hot with the steam valve wide open. There was sufficient steam pressure to do the work, but for some reason not all pipes would warm up. The steam entered the branch tee at one end as shown in Fig. 13. Then I hit upon the idea of arranging the supply pipes as shown at A with the inlet of the steam at both ends of the branch tee. This cured the trouble.

Irritatin'? Well!

By Chas. F. Knapp

I'M an engine operator—
I do all my work at night.
Since I must sleep in the daytime,
I must read by 'lectric light.

Winter time it ain't so bad;
Troubles then are few and small;
But summer time just keeps me busy,
Batting insects on the wall.

Buzzing, whirring, humming creatures,
Some are big and some are small—
Fleas, mosquitoes, moths and June bugs,
Lady bugs, beetles—and that ain't all.

Pesky critters! How I hate 'em!
Seems they can't leave me alone.
Bloody, blooming, bliming, blighters—
Always lightin' on my dome.

All the cranks, main journals, valve gears—
Anything that may go wrong—
Can be repaired—but darn those critters!
They're a pest all summer long.

The cost of fires each year is one-half the cost of all the new buildings erected in a year. The annual per capita fire waste in the United States is $2.51, in Europe, 33c. Cause: The latter has better construction, less carelessness, increased responsibility. If buildings in the United States were as fireproof as in Europe, the annual cost of fire losses and protection would be only $90,000,000.

Transmission Belts

THEIR PROPER INSTALLATION AND APPLICATION. FACTORS AFFECTING SELECTION OF BELTS. BY E. J. BLACK

TRANSMISSION belts, like delicate machinery, must be given proper care if the user expects them to give good service. This is such a self-evident truism that it would hardly seem worth repeating, and yet it is overlooked repeatedly. Belts which should be good for years of continued service are subjected to abuses which soon render them useless, and in many cases the manufacturer is blamed for having put out a defective product, when in reality the belt was faultless.

Unjustified claims for adjustments on injured belts are made frequently by disgruntled users. Every manufacturer can cite dozens of cases.

Reeently a belting manufacturer was asked to make an adjustment on a belt which had been torn along the length of the belt for several yards at either end. The owner was vehement in his claims that the belt was defective; but when an examination of the belt was made, it was clearly shown that the only cause for the injury was improper lacing. The holes for the lacing had been punched haphazardly and with no regard for providing an even strain on the belt. The result was that when it was put in use it ripped apart, and the belt was practically ruined.

Improper lacing is probably the most common mistake which users make, and yet it is the one which causes the most serious trouble, often completely nullifying all the knowledge and skill which the manufacturer used in making it. There is no excuse for ruining a good belt in this way. By observing the following simple rules, the belt will give the best service of which it is capable:

1. Cut the ends of the belt absolutely square. Do not depend upon your eye or use an ordinary ruler. If the end is slanted in the least degree, the pull will all come upon one side of the belt, and the consequences are likely to be disastrous.

2. Make the holes as small as practicable. Use an awl rather than a punch, whenever possible.

3. Leave a sufficient margin at the edge of the belt without holes, so as not to impair its strength. In belts 2 to 6 in. wide, the holes should be not nearer to the edge than ½ in.; in belts 6 to 12 in. wide, not nearer than ⅝ in., and belts 12 to 18 in. wide, not nearer than ¾ in.

4. Make two rows of holes, in parallel lines straight across the width of the belt, and stagger the holes, so that the strain comes upon different portions of the belt.

5. Be sure that the holes in the two ends to be joined match exactly. Otherwise there will be a "jog" in the belt, and this is likely to result in tearing the belt lengthwise.

6. Use flexible lacing, being careful to have it proportionate to the size of the belt. A heavy lacing is likely to cause trouble.

7. In lacing the belt, make the pulley side as smooth as possible. Rough places and ends should be turned away from the pulley.

8. In using metal fasteners, select those which place the strain on the lengthwise strands of the belt. The crosswise strands are not as strong as those which run lengthwise.

Besides improper lacing, there are many other abuses which cut down the life of belts. Shafting that is out of line may cause an undue strain upon the belt and make it run off the pulley. Oil may be allowed to drip upon the belt and ruin it. The belt may be applied with an initial tension so great as to produce unnecessary strain.

Many complaints regarding unsatisfactory belt performance can be traced to the fact that the wrong belt

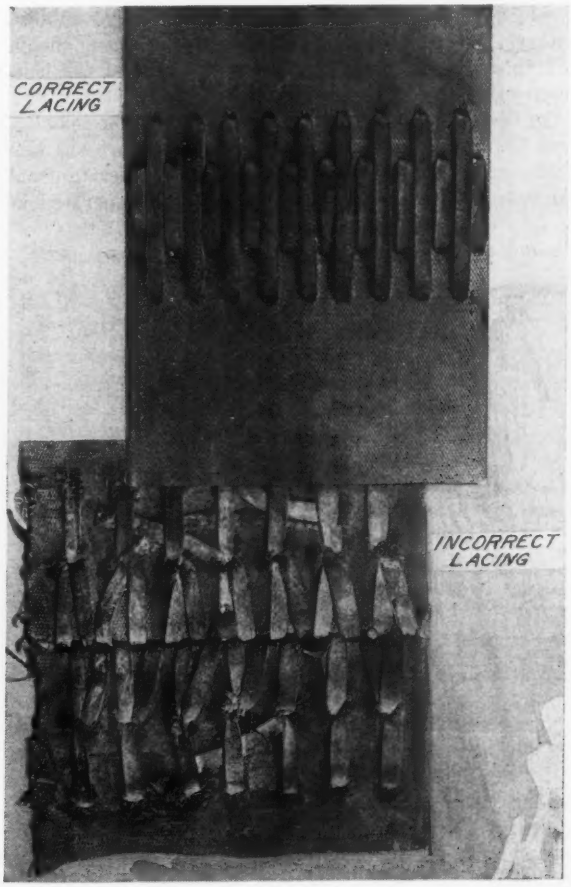


FIG. 1. ILLUSTRATIONS OF PROPER AND IMPROPER BELT LACINGS

was used on the job. No matter how good a belt is or how good treatment it receives, it will fail to give satisfactory service if not adapted for the use to which it is put.

FACTORS AFFECTING SELECTION OF BELTS

IN DECIDING upon the right belt for any particular installation, there are eight factors to be considered: (1) distance between pulley centers; (2) diameter of the pulleys; (3) width of the pulleys; (4) use of idlers, cone

pulleys, quarter-turn, half-turn, etc.; (5) speed; (6) horsepower to be transmitted; (7) load jerky or constant, and (8) conditions such as contact with moisture, oil, or other deteriorating influences.

Over these factors the belt man usually has little or no control. His problem is to take the conditions as he finds them and apply a belt that will give the best service possible under the circumstances. Yet he may sometimes perform a real service by calling attention to a faulty arrangement, when the conditions are such that the fault may be corrected. Real economies may sometimes be effected by lengthening the distance between pulley centers, increasing the width of the pulley face, or by changing the arrangement of a vertical belt so as to give a certain degree of slant.

The factors which are under the belt man's control are these:

(1) The kind of belting to be used, such as rubber, leather, canvas, etc.; (2) the grade—whether cheap, medium or high grade, and (3) the weight of the belt, such as 4 or 6-ply, single or double.

In deciding upon the grade for a particular installation, the points to be especially considered are the size of the pulleys, the presence of idlers or other unusual conditions, and the speed. Small pulleys, operated at high speed, necessitate a high quality belt. The reason for this is the internal wear between the various plies of fabric, and even between the fibers in each ply, as the belt rounds the pulleys.

TABLE FOR DETERMINING THE HORSEPOWER OF A BELT

		Speed in feet per minute.												
Width	Ply	400	600	1000	1600	2000	2800	3000	3500	4000	4800	5000	5500	6000
4"	4	1.45	2.64	7.27	10.9	14.5	18.2	21.8	25.4	29.0	32.7	36.4	40.0	43.6
	5	1.82	4.55	9.1	13.6	18.2	22.7	27.3	31.8	36.4	40.9	45.4	50.0	54.6
	6	2.18	4.55	10.9	16.4	21.8	27.3	32.7	38.2	43.6	49.0	54.5	60.0	65.5
5"	4	1.82	4.55	9.1	13.6	18.2	22.7	27.3	31.8	36.4	40.9	45.4	50.0	54.6
	5	2.27	5.68	11.4	17.1	22.8	28.4	34.1	39.8	45.5	51.1	56.8	62.5	68.2
	6	2.73	6.82	13.6	20.5	27.3	34.1	41.0	47.8	54.5	61.4	68.2	75.0	81.8
6"	4	2.18	5.45	10.9	16.4	21.8	27.3	32.8	38.2	43.6	49.0	54.5	60.0	65.5
	5	2.73	6.82	13.6	20.5	27.2	34.1	41.0	47.8	54.5	61.4	68.2	75.0	81.8
	6	3.28	8.18	16.4	24.6	32.8	40.9	49.1	57.2	65.5	73.7	81.9	90.0	98.2
8"	4	2.91	7.27	14.5	21.8	29.1	36.4	43.7	51.0	58.2	65.5	72.7	80.0	87.3
	5	3.64	9.1	18.2	27.3	36.4	45.5	54.6	63.6	72.7	81.9	91.0	100.0	109.2
	6	4.37	10.9	21.8	32.7	43.6	54.5	65.5	76.4	87.3	98.3	109.0	120.0	131.0
10"	4	3.64	9.1	18.2	27.3	36.4	45.5	54.6	63.6	72.7	81.9	91.0	100.0	109.2
	5	4.55	11.4	22.7	34.1	45.5	56.9	68.3	79.5	91.0	102.3	114.0	125.0	136.4
	6	5.46	13.65	27.3	40.9	54.6	68.2	81.8	95.5	109.0	122.6	136.4	150.0	163.6
12"	5	5.46	13.65	27.3	40.9	54.6	68.2	81.8	95.5	109.0	122.6	136.4	150.0	163.6
	6	6.55	16.3	32.7	49.1	65.5	81.7	98.2	114.4	130.9	147.0	163.5	180.0	196.0
14"	5	6.36	15.9	31.8	47.7	63.6	79.5	95.5	111.4	127.2	143.0	159.0	175.0	191.0
	6	7.64	19.1	38.2	57.3	76.4	95.5	114.6	133.8	152.8	172.0	191.0	210.0	229.2
16"	5	8.73	21.82	43.6	65.5	87.3	109.0	131.0	152.7	174.6	196.5	218.0	240.0	262.0
	6	11.63	29.1	58.2	87.3	116.5	145.5	174.6	203.6	232.6	262.0	290.6	320.0	349.2
18"	6	9.82	24.6	49.1	73.7	98.2	122.8	147.4	171.8	196.4	221.0	245.6	270.0	294.8
	8	13.09	32.7	65.4	98.3	130.9	163.4	196.6	229.0	261.8	294.0	326.8	360.0	392.5
20"	6	10.9	27.3	54.5	81.8	109.0	136.5	163.6	191.0	218.0	245.6	273.0	300.0	327.2
	8	14.5	36.4	72.7	109.0	145.5	181.9	218.0	254.8	291.0	327.7	363.8	400.0	436.0
24"	6	13.09	32.7	65.4	98.3	130.9	163.4	196.6	229.0	261.8	294.0	326.8	360.0	392.2
	8	17.4	43.6	87.2	130.8	174.4	218.0	261.6	305.0	348.8	392.0	436.0	480.0	523.6
30"	6	16.3	40.8	81.6	122.4	163.2	204.3	245.0	286.0	326.4	368.0	408.6	450.0	490.0
	8	21.8	54.5	109.0	163.8	218.0	272.8	327.6	382.0	436.0	492.0	545.6	600.0	655.0
32"	10	27.3	68.2	136.4	204.5	272.0	341.0	409.2	477.4	545.0	614.0	682.0	750.0	818.4
36"	8	26.2	65.5	131.0	196.5	262.0	327.6	393.0	458.0	524.0	589.0	655.0	720.0	786.0
	10	32.7	81.8	163.6	245.4	327.2	409.0	490.8	573.0	654.4	737.0	818.0	900.0	981.6
42"	8	30.5	76.4	152.7	229.2	305.4	382.0	458.4	535.0	610.8	687.0	764.0	840.0	916.8
	10	38.2	95.5	190.2	286.6	382.0	478.0	573.0	668.0	764.0	860.0	955.0	1050.0	1146.0
48"	8	34.9	87.3	174.6	261.9	349.0	437.0	522.8	612.0	698.0	785.0	874.0	960.0	1047.6
	10	43.6	109.0	218.0	327.0	436.0	546.0	654.0	764.0	872.0	982.0	1092.0	1200.0	1308.0

In specifying the proper ply for the installation, the determining factors are the size of the pulleys, width of the belt, speed, and the horsepower to be delivered. The belt itself should be at least 1 in. less in width than the face of the pulley. With this in mind, the proper ply can be determined by consulting a table of horsepower and plies. To illustrate: If you have a pulley whose face is 13 in. wide, operated at a speed of 4000 ft. per minute, with a maximum load of 100 hp., you will find by referring to the table that a 12-in. 5-ply belt operating at 4000 ft. per minute will transmit 109 hp. and you will specify accordingly. In specifying the ply, it must also be remembered that the greatest number of plies to be used on a 12-in. pulley is four, on an 18-in. pulley, five plies; on a 30-in. pulley, 6 plies; 40-in., seven plies, and 48-in., eight plies.

Are You on the Alert?

By W. F. Schaphorst

THE superintendent, foreman, manager, owner or anybody connected with a plant should constantly keep his eyes open for possible improvements in equipment. Improvements are almost invariably possible and profitable.

It is sometimes stated that "every man should be his own efficiency engineer." True. It isn't wise always to sit with hands folded and "wish" that you were an engineer or that an efficiency engineer would come and look the place over for little or nothing and give some good advice.

In fact, maybe you ARE an engineer. According to the definition recently handed down to us by a corps of savants and backed by the U. S. Government, an engineer is "one who economically directs manpower and by scientific design utilizes the forces and materials of nature for the benefit of mankind."

It is evident, then, that any man in any plant can be an engineer regardless of age, position, nationality, education, size, or anything of the sort. Let us "direct our own man power." Let us use our "intellects." By so doing, we will benefit mankind as well as ourselves. We may not wish to call ourselves "efficiency engineers" because it is true that many individuals of meagre experience hide behind that name. About all they do, very often, is to "pose." Posing is not engineering.

For example, take a look into the heating end of the plant. Often it is possible to save much fuel and money by making a few simple and inexpensive changes. One case was called to my attention where a device that required heat simply to run at high temperature was consuming as much steam as the main driving engine. The device was operated on live steam, whereas the engine was operated condensing.

Simply because the plant had been designed that way and had always been operated that way, it did not occur to anybody that steam and fuel were being wasted. The quantities of steam used in the engine and device had never been measured. Nobody had thought of inserting a steam flow meter into the steam lines. The matter had appeared insignificant—an everyday uninteresting, unimportant matter.

Usually, the larger the plant the greater the number of combinations and the greater the opportunity for the ambitious man to recognize saving possibilities and "utilize the forces and materials of nature."

It is well to take a live interest in all departments—to understand thoroughly as much as possible. Simply because a machine is being installed in a department with which I am not connected, is no reason why I should not take an interest in it. Is it going to be used for heating? Ventilating? Pumping? Driving? Exhausting? Will it use steam? Belt drive? Electric drive? How much power will it consume? What is its efficiency? Why is it going to be driven by electricity, belt, or rope? Why wouldn't some other method be better? Wouldn't it be wise to make an improvement *now* before coupling up? These are questions that one can ask oneself and others without becoming obnoxious. Don't be afraid to learn, to investigate, to read technical magazines, to tell what you know—to ask questions.

A Fuel-Oil Installation

(Continued from page 506)

The work will also have to be planned with some care, in order to run two pipes simultaneously and make up the joints properly.

That part of the oil line which is run in the ground is to be run through 12-in. pipe. Standard sewer pipe is to be used and it is to be split by cutting with a cold chisel along the sides, lengthwise so that it can be split easily. The two halves should be carefully marked so that they will go together again at exactly the same point, insuring tightness. (Author's Note.—It was ascertained that sewer pipe could be purchased already cut in half, but this cost 80 cents per foot, approximately. Whole pipe comes in 2 ft. lengths and costs 40 cents per foot. A few whole pipes were split for trial and it was found that one 40 cent an hour man could split about six pipes per hour. This made the net cost of the pipe split in this way about 43 cents per foot as the man of course split the 2 ft. lengths. Actual experience proved that he averaged about seven pipes per hour and

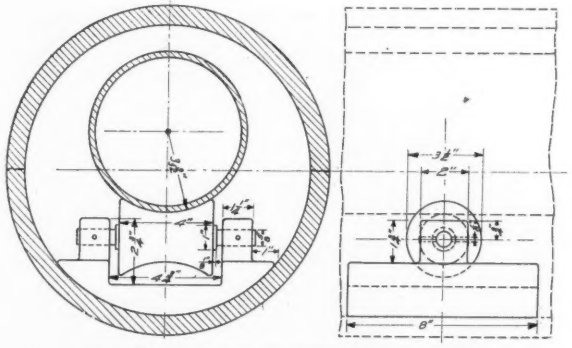


FIG. 9. DETAILS OF SPECIAL PIPE CHAIR

that he spoiled only one pipe in fifty. Therefore quite a respectable saving was made in this way as we used about 800 ft. of pipe.)

It is suggested that in order to support the 6-in. pipe inside the sewer pipe, a special hanger be made that will lie in the bottom half of the sewer pipe and support the 6-in. pipe so that it will be free to move longitudinally. The ditch in which the pipe is laid should be carefully graded, the bottom half of the sewer pipe laid to grade, the special chairs placed in it, the 6-in. pipe laid in place, and the top half of the sewer pipe fitted onto the lower half, after which the joint can be closed on the outside by grouting with concrete.

To provide for expansion, there are three expansion joints in the line, these to be corrugated copper joints, four corrugations, with cast iron equalizing rings. Two of these expansion joints are located in manholes. The third one should be just outside the river wall, near the bridge which crosses from the No. 7 mill.

(Author's Note.—Figure 7 depicts one of the manholes under construction; one of the special pipe chairs, and a portion of the 6-in. oil line lying inside of the sewer pipe which had previously been split and joined together again after laying as noted above.)

Where the pipe turns at sharp angles, there are manholes shown on the drawing at expansion chamber "A" and expansion chamber "B." These special fittings are shown in detail in Fig. 10. They consist of cast iron pots with faced bosses tapped for stud bolts, so that the pipe flanges can be bolted directly to them. These special fittings not only provide for the turn in the pipe, but also for the expansion of the steam pipe which is run inside the oil pipe, through the use of metallic tubing.

Provision has already been made for the introduction of the steam pipe into the oil pipe at the pump house, and also at the service tank end of the line. This provides two separate steam lines, which meet at expansion chamber C. At this point these lines drain through lengths of metallic hose which are connected into nip-

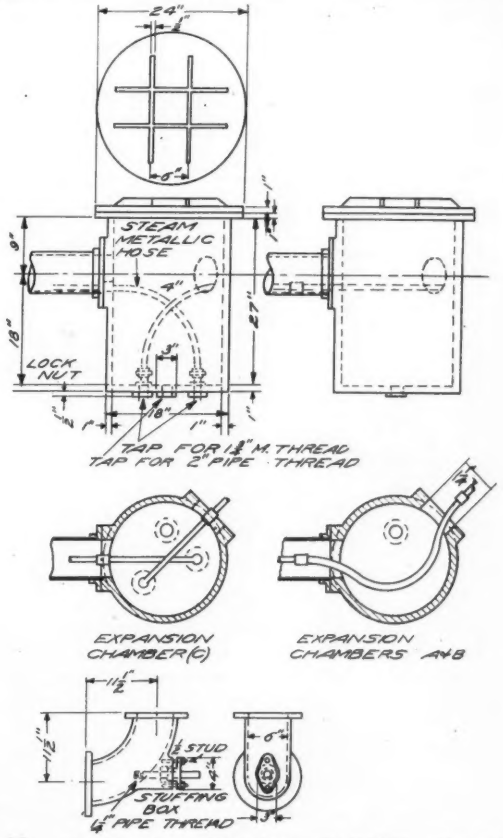


FIG. 10. DETAILS OF EXPANSION CHAMBERS AND LONG-SWEEP ELBOW

ples passing through the bottom of expansion chamber C, so that these lines can be trapped.

Expansion chamber "B" is not located in a manhole because the line from a point near expansion chamber "A" down to the expansion joint near the No. 3 mill is not laid in the ground. This part of the pipe must be hung from special hangers, so that it will be free to move. It is suggested that hangers be made which can be bolted to the foundation wall of building No. 7, these being in the form of right angle brackets with the top leg projecting out sufficiently far so that the 6-in. pipe with its insulation, will clear the wall when hung in pipe clips suspended from the brackets by means of iron rods ¾-in. diameter. After complete installation, this exposed pipe can be covered with a layer of asbestos paper, 1 in. of hair felt, a layer of fiber board, and a

final covering of waterproof roofing paper, cemented on. Expansion chamber "B" should be supported on a strong iron or steel shelf, bolted to the wall of the building, with balls or rollers under it, so that it can travel with the expansion and contraction of the pipe. This expansion chamber should be covered in the same manner

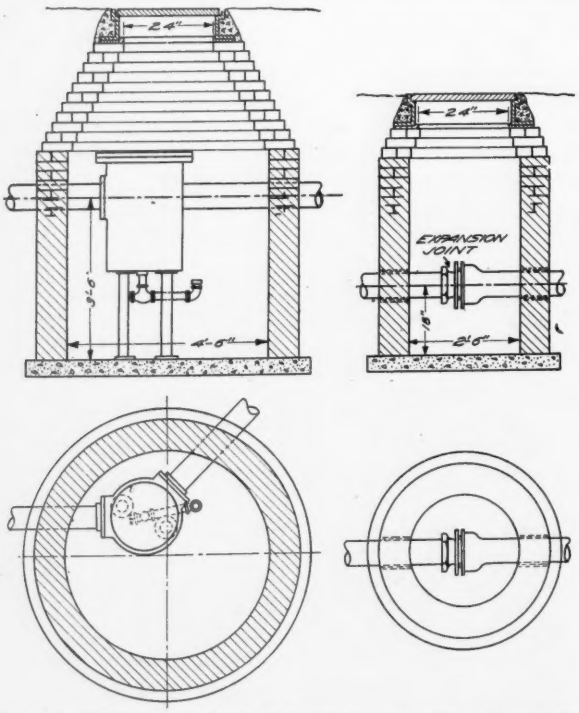


FIG. 11. SECTION THROUGH EXPANSION CHAMBER MANHOLES

as specified above for the pipe, to secure good protection from the weather.

Each of these expansion chambers should be provided with a bottom outlet, for the attachment of the valves and fittings whereby the line can be pumped out in case of necessity. This is shown in detail in Fig. 11.

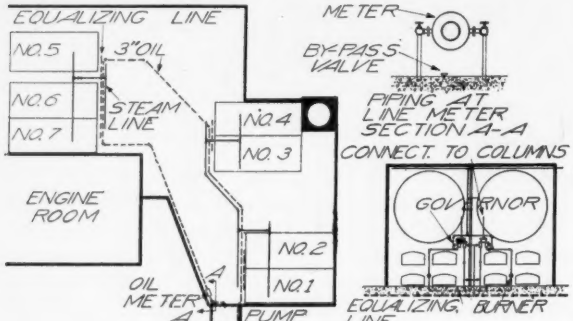


FIG. 12. LAYOUT OF BOILER ROOM OIL PIPING

The steam line which is run inside of the oil line is to be of 1¼-in. standard weight pipe, with couplings, all joints to be made up with glycerine and litharge. It is evident that as the 6-in. pipe is laid, the 1¼-in. pipe will have to be laid at the same time, so that the joints will come out at the same places in the line. As each section is laid, it should be tested out, i.e., when the line has been run from the pump house to expansion chamber "A" the 6-in. line and the 1¼-in. should be blanked off and tested out with cold water at 100 lb. pressure, to make sure that they are tight. Then as the line is run from expansion chamber "A" to expansion chamber "B," it should be tested again, and so on throughout the entire length. After the entire pipe line has been laid it is again to be tested out, preferably with air pressure as well as water pressure, so that there will be no doubt about the tightness of the oil and steam lines. (Author's Note.—The lines were laid about as specified, except that it was begun at the service tank and laid toward expansion chamber C instead of the other way. As air and water pressure were not available readily, we tested out all the pipe lines with 125 lb. steam pressure and it was well that we did so, as one or two couplings developed defects which could not be detected with the naked eye and in spite of all our care to make up the joints tight, in some cases we had to try three times before securing a tight joint.)

Reference has been made to the manner of introducing the steam line into the oil line, and to pack it against the leakage of oil. In Fig. 10 is shown a bossed elbow. It is possible to buy long-turn elbows with back-bosses

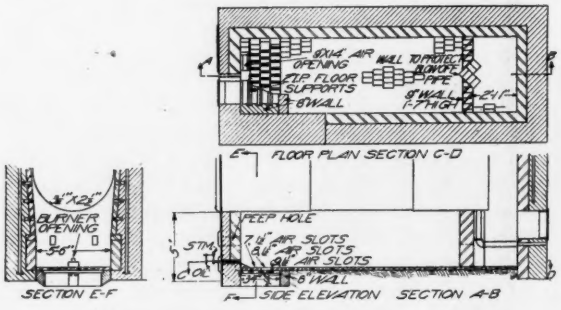


FIG. 13. OIL BURNING COMBUSTION CHAMBER

on them, and it may be possible, in this case, to use such a fitting, specially drilled and bored out for a stuffing-box through which a short length of brass pipe can be passed and properly packed. If such a fitting cannot be found then a regular bossed elbow could be used, and the steam pipe threaded and run through the usual tapping of the boss, special care being taken to make up a tight joint. (Author's Note.—The special bossed elbow could not be obtained anywhere from stock, so two elbows were cast according to the drawing and they have worked O. K. They cost about $60 each when finished.)

The metallic hose which has been referred to, should be of copper, and on each end should be brazed one-half of a ground joint brass union, the other half of the union to be screwed to the steel steam pipe. Each length of this metallic hose should be made as long as possible, so as to provide the greatest flexibility.

The 1¼-in. steam pipe should terminate well back of the end of the 6-in. oil pipe, so that the union would be in the 6-in. pipe.

Changing Over to Oil

Construction work on the main storage tank and pipe line was completed about the first of December, 1919, and the service tank had been poured, but was not yet tight.

In the meantime the load demands in the plant had increased to such an extent that we could not keep steam up in the lower boiler house and were thus retarding production. It was uncertain as to when the service tank would be ready for operation and we, therefore, placed a small steel tank of about 1000 gal. capacity on the ground just back of the service tank and piped it up in a temporary manner in order to begin using oil. We had already cut over one boiler and adapted it to burn oil. Figure 13 shows how the oil furnaces were built.

On the morning of Jan. 1, 1920, word was given to start the large transfer pump near the main storage tank in which we had already placed about 100,000 gal. of oil. In about one-half hour oil began to pour into the steel tank and we filled it up. In the afternoon, we started the service pumps and heated up the oil in the line around the boiler room. At about two o'clock, we lighted No. 7 boiler and had the satisfaction of seeing the oil burning under the first boiler. The fire sputtered and flickered a good deal but this was due to water which we had previously let into the pipe line while testing the main tank. To get rid of this water, we placed an

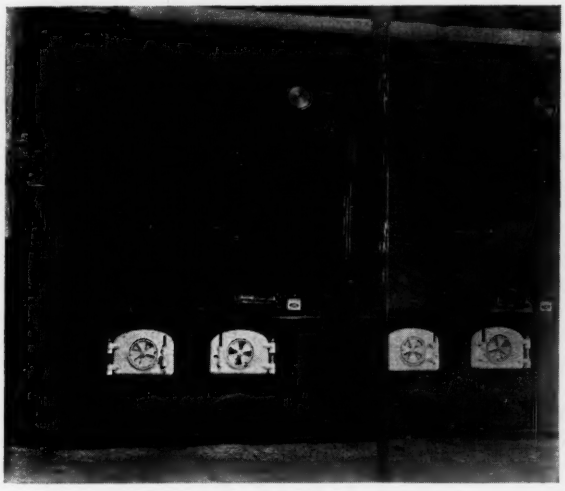


FIG. 14. TYPICAL BOILER FRONT

ordinary pitcher pump on the end of a long pipe and inserted the pipe in the steel tank and pumped the water out until pure oil came. Then the fires ran O. K. For several days thereafter we had to repeat this process of getting rid of the water and we therefore placed a pitcher pump in the service pump room as a part of the permanent equipment of the system. We only use it occasionally now and then, after we have unloaded a tank car, in which the steam heating coils are broken inside of the car allowing live steam to come in contact with the oil.

At first, we used the 1¼-in. steam line which was placed inside the 6 in. transmission line whenever we pumped from the main tank to the service tank, but later experience demonstrated that this was not necessary as the heater under the transmission pump heated the oil up sufficiently to enable us to pump it without further heating. When the transmission pump is first started, the pressure on the discharge line frequently goes up to 100 lb. This obtains for several minutes and then the pressure sinks to 20 lb. and the oil flows very readily. We make it a practice to pump a little oil over each day so as to prevent the oil which lies in the pipe line from becoming so cold that it will not start. It is our present intention to install a 6-in. valve on the line at the service tank end and, as the transmission pump has a governor, it will only be necessary to keep the pump going slowly all the time and shut the valve at the service tank when the tank is filled. This will do away with the service of a man who has to run the transmission pump a little while every day.

To continue with the story of the installation: It took us the whole month of January to finish cutting all of the boilers over from coal to oil and clean up the boiler room.

This has now been accomplished, however, and we are at present running full blast on oil. Somewhat to our

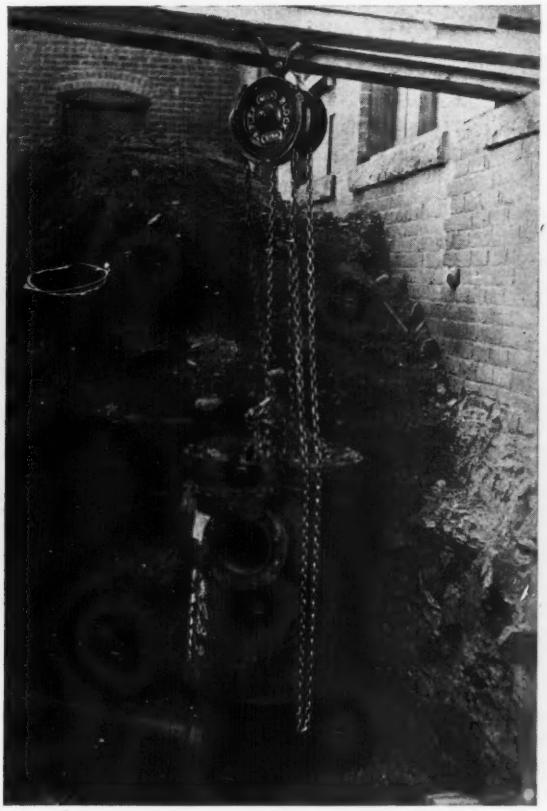


FIG. 15. ONE OF THE EXPANSION CHAMBERS BEING LOWERED INTO PLACE

surprise, we have had to increase the capacity of our water meters for measuring feed water, for as yet our feed-water regulators have not arrived and when the pulls are hard, the pen goes off the chart entirely. This certainly shows that we are getting the increased capacity that we went out for.

In closing this article, I cannot do better than give data on the comparative evaporative tests of these boilers with coal and with oil. The coal tests were made just before the boilers were cut over and the oil tests were made after the oil plant had been in operation for some time in order to get the fireman accustomed to regulating his fires. To my regret, it was impossible to obtain

CO_2 readings on the coal tests and therefore those tests are not as complete as I wished them to be. The tests speak for themselves and need no further comment. I might state that the entire boiler house is now operated with one day fireman and one night fireman. Formerly, with coal, this boiler house required the services of three day firemen, one coal and ash wheeler, and two night firemen. Even then, at times, when the load was very heavy, an extra man had to be put in on days and one on nights. This was particularly the case when the quality of the coal burned, fell off in the least and at that, with all this help, we could not maintain the required pressure at times. Now, some days, we operate with four or five boilers and have plenty of steam. In addition, we do not have to put ten or a dozen men on the trestle to unload coal cars for this boiler house in the winter, when the cars come in frozen solid.

Comparative Coal and Oil Tests

The following tests were run under ordinary conditions. No attempt was made to get a special record with either coal or oil. We were simply interested in determining the relative value of coal and oil as fuel

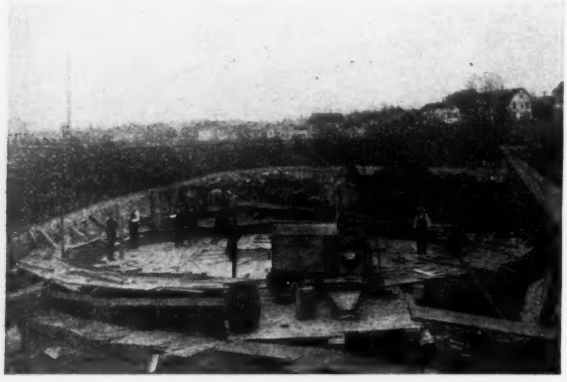


Fig. 16. Storage tank during construction, showing platform around outside for wheelbarrows and puddlers

in developing steam under our conditions and the relative cost of handling the two fuels in our yard. For these reasons, a complete evaporative test, containing flue gas analyses, calorimeter readings, etc., was dispensed with.

Test number 1 was run on only six boilers, as the seventh was at that time being changed over to oil. Tests numbers 2 and 3 were run on all seven boilers. The load on the plant is heaviest during the day, and at night from four to five boilers are usually banked. Tests numbers 1 and 2 were run straight through these banking periods and no special instructions were given as to banking, etc. Test number 3 was run during the period of heaviest load and was made to determine what was being done when the boilers were being run at somewhere near rating.

Brief Description of Method of Testing

Feed water was measured by an orifice flow meter installed in the discharge line of the feed pump, and the meter was checked up before the tests were begun. Coal was weighed out in about 400-lb. lots, as fired. Feed-water temperatures, steam pressure, flue temperatures, oil pressure and oil temperatures were taken every 15 min. All other readings were made every half hour. On test number 1, the fires were cleaned 2 hr. before beginning the test and 2 hr. before ending the test, and twice every 24 hr. during the test. Oil was measured by two meters, one on the oil discharge line and the other on the oil return line, the difference between the two giving the net oil used. These meters were checked up by measurements made on the oil in the service tank at the start and finish of each test. Special instructions were given not to blow down any of the boilers during any of the tests, and this point was carefully watched. Water columns were blown down just a slight amount every morning on all tests. The water line on each boiler was determined at the start of each test and brought to the same point at the finish of each test.

Brief Description of the Boilers

Boilers numbers 1, 2, 3, 4, 5, 6 and 7 (coal test run on first six and oil tests run on all seven) are horizontal return tubular boilers having a third pass or return. In other words, the gases pass along the bottom of the shell, entering the tubes at the rear tube sheet, pass through the tubes to the front of the boiler and then along the top of the shell to the rear of the boiler and into the flue. Numbers 1, 2, 3, 4, 6 and 7 have 92 3½-in. tubes each. Number 5 has 122 3-in. tubes. Length of shell in all seven boilers equals 19 ft. 6 in. Diameter of shells on all seven equals 72 in. On the coal test, the boilers were equipped with herringbone shaking grates and on the oil test steam atomizing oil burners were used with combustion chambers, as in Fig. 13. On the coal test, draft was obtained through the use of steam jet blowers, when necessary, and on the oil tests natural draft was used. No allowance was made for the steam used by the blowers on the coal test, and therefore no allowance was made on the oil tests for the steam used in atomizing the oil or pumping it, as it was estimated about the same amount of steam would be used in either case. Boilers numbers 1 and 2 are 16 yr. old. Boilers numbers 3 and 4 are 14 yr. old. Number 5 is 12 yr. old. Number 6 is 23 yr. old. Number 7 is 22 yr. old.

Comparative Costs from Test Data

In order to obtain the total cost of producing 100,000 lb. of steam, multiply the cost per pound of the respective fuel by the number of pounds required, as shown in the accompanying table, this cost per pound to be of the fuel on the trestle. Add the respective amounts shown for handling and firing.

For example: Assume that coal costs $6 a short ton, or $0.003 a pound, in cars on the trestle. Also assume that oil costs $1.50 a barrel, or $0.0045 a pound, in cars on the trestle.

Cost of producing 100,000 lb. of steam with coal, using the result as shown in test number 1:

$11{,}388 \times 0.003 = \$34.16$, the cost of the fuel.

$$\frac{11{,}388 \times 0.55}{2000} = \$3.14,$$ the cost of handling, etc.

$$\frac{11{,}388 \times 1.21}{2000} = \$6.90,$$ the cost of firing.

Total cost for 100,000 lb. steam equals $44.20.

Cost of producing 100,000 lb. of steam with oil, using the results shown in test number 2:

$\frac{7112 \times 0.0045}{} = \$32$, the cost of the fuel.

$\frac{7112 \times 0.07}{2000} = \$0.25$, the cost of handling, etc.

$\frac{7112 \times 0.48}{2000} = \$1.71$, the cost of firing.

Total cost for 100,000 lb. of steam equals $33.96.

TABLE SHOWING RESULTS OF COAL AND OIL TESTS

Boiler No.	Heating surface, square feet	Grate surface, square feet	Ratio-heating Surf. to grate Surf.	Nominal boiler horse power
1 & 2	1780	36	49.4 to 1	*178
3,4,6,& 7	1780	36	53.9 to 1	*178
5	1980	36	55.0 to 1	*198

*Based on ten square feet of heating surface per boiler horse-power per hour.

RESULTS			
	Test No. 1	Test No. 2	Test No. 3
	Coal	Oil	Oil
Date	Dec.17,18,& 19 1919	Mar.16,17,18 1920	Apr. 6 1920
Duration of test	54 hours	72 hours	5 hours
Boiler pressure-gage, pounds per square inch	100.6	96.9	103.0
Temperature of air in boiler room, degrees F.	57	84	76
Temperature of feed water, degrees F.	182.2	154.9	140.2
Temperature of oil in discharge line, degrees F.	—	110	122
Pressure of oil in discharge line, pounds per square inch	—	45	41
Draft in flue, inches of water	0.11	0.09	0.10
Draft over fire, " " "	0.28	0.17	0.18
Total fuel fired during test, pounds	143,632	158,855	16,718
Temperature of flue gases, degrees F.	385.0	360.0	380.0
Total ashes and clinker removed, pounds	13,617	—	—
Total water fed to boilers, pounds	1,146,750	2,050,800	210,500
Actual pounds of water evaporated per pound of fuel fired	7.984	12.910	12.591
Total equivalent evaporation from and at 212 deg.F., pounds	1,261,189	2,233,654	232,733
Equivalent evaporation from and at 212 deg.F. per pound of fuel as fired, pounds	8.791	14.061	13.921
Equivalent evaporation from and at 212 deg.F. per square foot of heating surface per hour, pounds	2.14	2.45	3.09
Coal burned per square foot of grate surface	12.85	—	—
Boiler horse-power per hour developed,- A.S.M.E. rating, horse-power	676.6	898.8	1348.6
Percent of nominal boiler horse-power developed per hour, percent	62.20	71.00	106.52
Fuel required to produce 100,000 lb. of steam at boiler pressure, pounds	11,388	7,112	7,183
Cost to transfer fuel from the trestle to the boiler house, including cost of removing ashes - all based on lots of 2,000 lb. of fuel	$ .55	$ .07	$.07
Cost of fire-room labor to burn the fuel - 2,000 lb. lots	$1.21	$ .48	$.48

The cost for number 3 test would be figured in a similar way and would be nearly the same, so is omitted. Net saving, oil over coal, in this case $10.24.

Assume that our demand for steam from this boiler house is 700,000 lb. every 24 hr. and that there are 300 working days in the year. Then the net saving by using oil instead of coal at the prices given above would be $10.24 \times 5 \times 300$, which equals $15,360 per year.

The writer has gone into detail in this article, for he feels that the entire installation is somewhat unusual on account of the long distance the oil has to be pumped and the new problems involved. He understands that pumping oil through long pipe lines is, of course, not new; but, at the same time, he does not know of another installation of this character in climates where the temperature goes down to 15 deg. below zero in the winter.

New vs. Secondhand Boiler

By N. G. Near

NOT long ago, I was told about the owner of a small plant who thought he saw a chance to save a little money by buying a secondhand boiler instead of a new one. Iron looks like iron to most folks, especially boilers—from the outside—and in this particular case, the outside looked like most outsides, and after being installed, the boiler went so far as to "act" like a real boiler. The owner patted himself on the back out of respect for his business acumen. After two months, however, the boiler began to leak. It didn't leak in one place only, but in a number of places. The tubes proved to be mighty weak, and the owner had to have this "good buy" partially re-tubed. He spent $150 to stop the leaks, nevertheless it persisted in leaking.

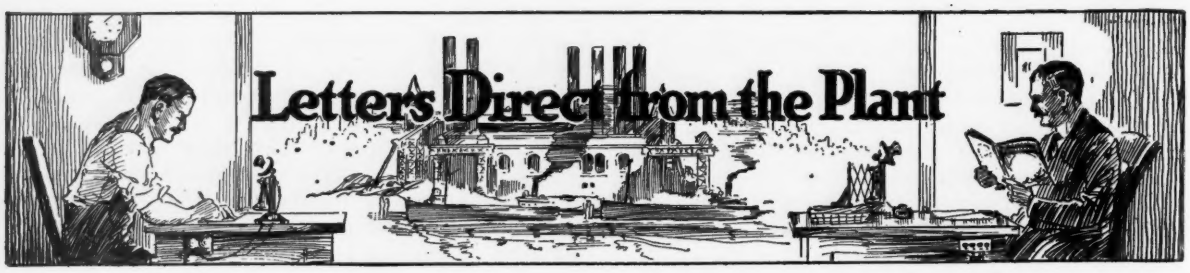
One month later, the owner acknowledged that he had erred and had the boiler thrown out. He didn't get three months' use out of the old boiler. Did he put in another secondhand boiler? Did he? What do you think? And after the new boiler was installed, the owner did some quiet figuring. He didn't tell about it from a public soap box, but on the Q. T. he learned that the cost of the old boiler, plus the cost of reduced output, plus the cost of repairs, was equivalent to "more" than the cost of the new boiler. Instead of getting a bargain, therefore, he paid for two new boilers and got only one.

True, a secondhand boiler is worth something as junk. I don't know the exact figure, but let us place it at 98 cents and 9 mills.

IN A CROWD of people discussing their likes and dislikes about various cities, an old fellow spoke up: "I've always said that when I hear a person say that he likes this city better than that, that he must have been feeling better when he was at the pleasing town."

There is a lot of philosophy in what the old man said; still, most people will admit, if they have traveled, that they have a favorite over the particular city wherein they reside. There is no harm in that, but they must remember what Cicero said: "Call that place home where you can make the best living." Cicero no doubt added, "and then boost for it."

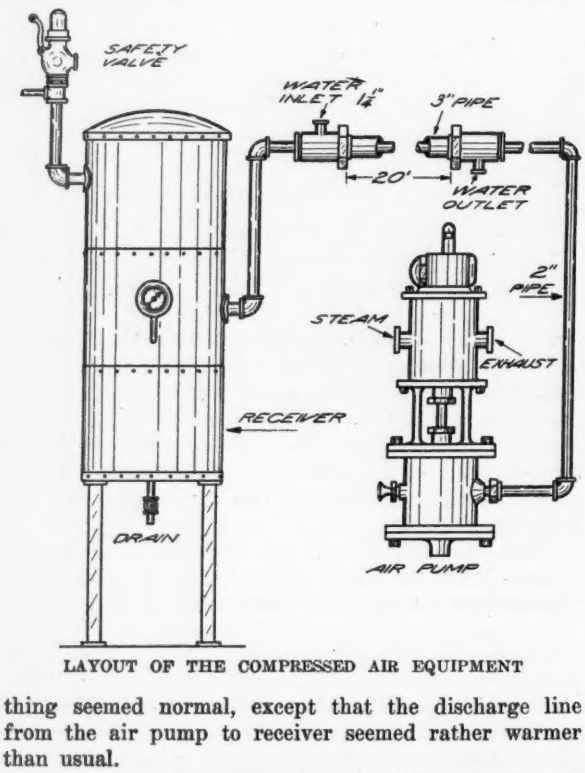
Hence it is, let us not envy the other fellow's town, but boost our own so much that we shall not have time to worry about the other's. The psychology of this attitude toward our own town applies as well to our own job.



Another Peculiar Accident

IT WAS with interest that I read R. B. R.'s article in the February 15 issue regarding the explosion in his air receiver. The Sunday and Monday after reading this article the same thing happened in our plant.

On Sunday we were pumping up the receiver, as usual for the day's operation and demand for air, when without warning the pop valve released and a 10-ft. jet of flame and much smoke burst forth. The pop valve was red-hot in no time. We shut down and examined everything from pumps to receiver, and everything seemed normal, except that the discharge line from the air pump to receiver seemed rather warmer than usual.



LAYOUT OF THE COMPRESSED AIR EQUIPMENT

We removed the safety valve, cooled it, and reground the seat and adjusted the spring for proper blowoff pressure, and installed it. We then pumped up to normal pressure (100 lb.) and everything seemed O.K. as far as we could determine.

Monday morning, shortly after starting up the air compressor (locomotive type), the same thing again occurred. I happened to be near the air compressor at the time and noticed that the air gage registered 65 lb. (blowoff pressure on receiver set at 110 lb.). The air compressor shook violently for a few seconds, then the safety valve let go with a roar, and the hand on the air gage went clear around to the pin, showing a pressure of 300 lb. or more. This time, the whole receiver was hot and burned out the handhole and manhole gaskets and several gaskets on the discharge line from compressor to receiver.

We immediately removed the manhole and handhole plates, examined the interior of the receiver and found a peck of small globes of carboniferous material resembling coke and about the size of peas. Some of these were still red-hot. The receiver was practically free from oil, probably due to the fact that we blew down the receiver every night after shutting down, to eliminate any oil or water that may have been entrained therein. No doubt there had been some oil on the sides of the receiver and this probably burned up when the receiver caught fire.

We use a mineral oil of high flash test, which is about the best we can procure for this work. This explosion, in my estimation, was caused by the excessive heating of the air going through the discharge line from the compressor to receiver, which was too small in diameter to carry the amount of air discharged from the pump without overheating, due to friction in the pipe line. The air passing through the discharge line heated up to a point where it carbonized the oil, and when it reached a point where a red-hot piece of carbon entered into the receiver, which was filled with air and vaporized oil, it naturally ignited.

We are going to try to remedy this condition in two ways—first, increase the discharge line from the pump to receiver from 1¼ to 2 in.; second, cool the air after leaving the compressor, by means of two 3-in. water inlet and outlet fittings, such as are used on double-pipe brine coolers and double-pipe condensers.

The accompanying sketch shows the relative layout of compressor, receiver and cooler.

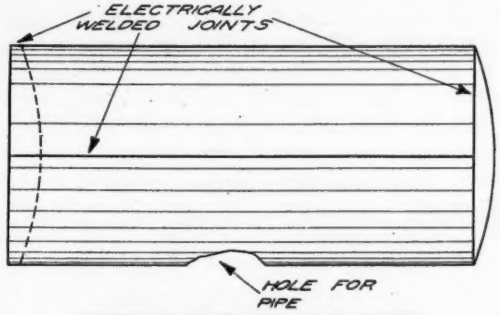
C. E. ANDERSON.

A Steam Trap Failure

ONE OF the lifting traps used in a certain plant to raise condensation from one receiver to another in the boiler room, has a cylindrical receiver located in a horizontal position when the trap is filling. The longitudinal seam of this receiver and the joints between the two heads and shell are electrically welded. This trap has given satisfactory service for 6 yr.

One afternoon during normal operation, one of the heads was blown completely off from the shell of the receiver. The head hit the floor about 2 ft. from the location of the trap, making a hole about 3 ft. square. The head, evidently striking the floor at an angle, continued across the room, a distance of about 40 ft., damaging a machine.

The outlet pipe from the trap, welded to the under side of the receiver, also broke off and the shell bent upward, as shown in the accompanying illustration. The live steam connection to the trap also broke off. Seven windows in the room were blown completely out of the casings and destroyed.



SHOWING HOW THE TRAP FAILED

An examination of the wreck disclosed that the joint uniting the head and shell was only caught and not properly welded. The results suggest the idea that it might be advisable for one having traps of a similar character to take the subject up with their boiler insurance company with the end in view of extending the inspection and policy to cover the traps which are pressure vessels. RECEIVER.

Further Remarks on the Refining of Crude Petroleum

I SEE that John S. Blair takes "unqualified issue with 99½ per cent" of my statements in the mid-February number regarding oil refinery engineering; yet he does not correct the things to which he takes issue.

In discussing technical questions, one should refrain from generalities. It is far better to take up alleged mis-statements one at a time and analyze and correct them, than brand the whole as "misleading" and to charge the author with being "not familiar with this particular industry."

Had Mr. Blair given us the benefit of his 15 yr. experience in oil refining, by explaining the conditions that I described, he would have conferred a favor on many who have not had his experience. Instead, he admits that "there are many plants operating with a sinful waste of fuel." Further than this I did not go.

As stated in my previous letter, the kind of still described was provided with as many as three 12-in. vapor pipes. These I characterized as ridiculously large. Mr. Blair, however, declares that they "are so designed to prevent the cracking of the vapor so detrimental to the production of first-class gasoline." Just how these pipes, which are exposed for their entire lengths to the atmosphere, influence "cracking," is not clear. The vapor in these pipes, or "run-back" lines, is being rapidly cooled and so could hardly be further "cracked," this operation (requiring high temperature) having been performed in the still whence they came. My impression has been that these vapor lines are inclined for the purpose of returning the heavy "ends" to the still. Should Mr. Blair take the output of this still in cubic feet of vapor for a given period and divide it by the cross-sectional area of the vapor pipes, he would find that the velocity of the vapor going through the pipes is extremely low. I insist that if these pipes are for the purpose of conveying vapor, they are much too large for economy; and if for the purpose of radiation or condensation, a better proposition could be devised.

Mr. Blair says he does not understand what I mean by the word "efficiency" as applied to condensers. He states that "efficiency" is a "comparative" term. While this word has been used rather loosely to denote effectiveness and gratifying results, its use in engineering is rather limited. The "efficiency" of a mechanism is the ratio of output to input and in manufacturing processes the method that produces a given result more cheaply than another (considering cost of equipment as well as cost of operation) is termed the most efficient. Comparative efficiencies of condensers depend on costs and effectiveness of the surface. If the desired result can be obtained with one condenser at less cost than with another, then the first is the more efficient.

Heat transfer is a rather complicated subject and knowledge of its action requires one to possess data such as the state and the velocity of flow of the fluids on both sides of the separating wall (which determines the coefficient of heat transfer) and the mean temperature difference. This last is determined from a consideration of the relative directions of flow of the fluids (that is, whether there is counter-flow or parallel-flow) and whether one or both fluids maintain constant temperature, or whether the hot fluid has a falling temperature and the cooling fluid has a rising temperature.

The net result of properly designing condensers is a saving in surface—the water requirements of all kinds (considering temperatures, of course) being the same.

Were it not for the latent heat of the oil, there would be no need of water-cooled condensers and there would be no heat loss aside from that required to effect heat transfer; but as the latent plus the sensible heat provides more heat than is necessary to raise the temperature of the incoming oil to nearly still temperature, resort is had to water as a cooling medium. Most refineries, however, do not attempt to recover the heat in the still vapors—this heat being taken up by the cooling water and wasted. An idea of this waste may be had when one considers a latent heat of evaporation of upwards of 150 B.t.u. per pound and, in the case of some "cracking" plants, a temperature of about 750 deg. F.—a loss of nearly 500 B.t.u. per pound of output. This, coupled with the waste due to faulty furnace design, makes the refinery a rather wasteful plant.

It is expected that the rising price of fuel will cause a readjustment of the practice in many refineries; some, no doubt (as Mr. Blair assures us), having already adopted economical methods. But as long as refineries operate under the conditions described in my letter in the Feb. 15 issue, there will be a great waste of fuel. Data on fuel consumed and the amount of output (that is, a heat balance) bears this out.

Mr. Blair states that I probably do "not know that it is not desirable to bring the condensed vapor to a very low temperature, due to the congealing of the heavier oils in the pipe." Yes, I do know this, and, as

it is not a very obscure fact, I presume that nearly everybody knows it; but just how the design of a condenser can bring about congealment is not clear. In the submerged condenser the vapor comes in at the top and the cooling water at the bottom (counter-flow) and if the temperature of the incoming water is above the congealing temperature of the oil, a condenser of infinite extent would not cause congealment. To prevent congealment, then, all that is necessary is control of the temperature or volume of the water.

My purpose in writing the article of Feb. 15 was to evoke an explanation of the conditions described. This Mr. Blair has not done. Charging me with unfamiliarity with refinery practice, or even positive ignorance, does not satisfy the requirements of the case.

I would suggest that Mr. Blair take up the points raised in my former letter and, in a judicial calm, analyze them. I think he will then find that, so far from them being 99½ per cent awry, they are very nearly correct. Allowance must be made, of course, for the possibility that Mr. Blair has been connected with only the exceptional refineries, and consequently is unfamiliar with the conditions described in my letter.

It is easy to understand how the oil refinery business has grown to such proportions and with comparatively little improvement in methods. Because of the nature, and uncertainty of supply, of crude oil, the business has been one of "getting while the getting was good" and design (if the word "design" is applicable) was carried out by men whose knowledge of the design of power-plant and similar apparatus, has been designated as "connecting a hole in a boiler with a hole in an engine."

Nothing in the foregoing is intended to reflect on anybody. That the builders and operators of oil refineries have done the best they could, goes without saying. The pity is that men of special training had not been called in until perhaps recently. This, no doubt, has been due to lack of information on the part of owners and managers. There are many managers of manufacturing plants who cannot believe that there is room for improvement as long as the wheels go around and the smoke comes out of the stack.

C. O. Sandstrom.

Firing Sectional Heating Boilers

Doubtless many of the readers of Power Plant Engineering fire sectional heating boilers. I found it hard to keep up steam without being at the boiler every half hour. As I had other work to do besides firing, I tried every method I could think of. The pressure carried was 3 lb. and if the doors were left open too long, the pressure would quickly drop.

The stoker method is one way I tried and with it I was able to keep steam up continually. This way was to put the fuel on the fire just inside the doors, applying it quite thickly. About a half hour later push the live coals from the front toward the back of the grates, applying more coal on the front. These operations must be done as quickly as possible if a low steam pressure is carried.

Another method which I tried is a better one and I am now using it. First, find the most economical draft that can be carried; this can be done by manipulating the dampers until the right draft is found. Then raise the steam pressure to 4 or 5 lb., adjust the dampers so as to get the proper draft which will be sufficient to carry your fire.

Then shovel coal on the front half of the grates. This fuel is applied thickly, filling up the holes around the doors. A little sprinkle of coal on the back half and the fire is set. This will last an hour or more. After the hour is up, take your hoe, push the fire well back and do as before. In this way, no trouble will be encountered with "no steam." Clement Corey.

Refilling a Brine Tank

Recently I employed a somewhat unusual scheme to refill the brine tank of our cold-storage system. First I filled the tank with water and then placed over it near the return pipe of the circulating system a barrel fitted with a perforated bottom and another false bottom of heavy wire netting fastened to a frame of two-by-fours. A large galvanized-iron funnel with a perforated head similar to that of a sprinkling can and a 1¼-in. nipple on the opposite end was attached to the return pipe of the brine system, the funnel so placed as to be directly above the barrel.

Starting the circulating pump and pumping the water through the system and into this barrel, I was able to dissolve 13,000 lb. of calcium chloride in 6 hr., this with the assistance of two men who broke up and placed the calcium chloride in the barrel. W. H. Hill.

Quick Pump Repair

Some time ago, the stuffing box on the water end of a duplex pump blew out, stripping the threads, which were badly corroded, after long service. The flanges were cleaned and put back in place with sheet rubber packing and white lead between the flange and the cylinder head. Pieces of 1½-in. hard wood were then cut to length equal to the distance between the water end stuffing box and the steam cylinder. These were put into place and fastened with wire and the pump was back in service within 15 min. E. G. M.

A Continuous Run Record

We have an 875-kw. generator, direct-connected to a water wheel, operating under a head of 170 ft. This unit made a continuous run from Dec. 15, 1919 to April 18, 1920 without being shut down for any purpose whatever. We think this is going some and would like to hear of other units of this size that have done as well, operating under as high head.

Deer River Power Co.
V. C. Wood, Supt.

The kids were passing the coal yard of the power house. There were several streams of water being thrown on it.

"Say, Johnny! What's the idea? I don't see any fire."

"Ah, dat guy dat owns de dump tinks it makes de coal swell and he tinks it last longer. He's what I'se calls stingy."

Useful Kinks for Engineers

BELIEVING the readers of Power Plant Engineering would be interested in them, I am presenting herewith sketches of a number of readily constructed contrivances of utility to the engineers. That shown in Fig. 1 is a snap gage having an adjustable scale 2 in. in length and reading in 32nds and 64ths of an inch. Scale C is adjustable by means of knurled nut G carried along screw F and can be locked in place by means of thumb screw D. Anvil B is made of tool steel hardened and ground to a square surface.

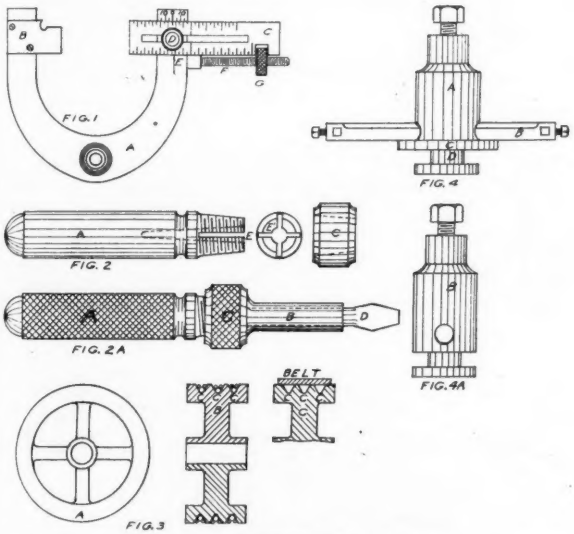


FIG. 1. A USEFUL SNAP GAGE

FIG. 2 AND 2-A. INSULATED SCREWDRIVER FOR ELECTRICAL WORK—DETAILS AND ASSEMBLY

FIG. 3. GROOVED PULLEY ARRANGED FOR BELT DRIVE

FIG. 4 AND 4-A. ALL-AROUND BORING BAR AND POST FOR LATHE WORK

Micrometer adjustment can be made by graduating nut G into five divisions and providing screw F with a 20 thread so that one turn of the nut will advance the scale 0.050 in.

Figures 2 and 2-A represent an insulated screwdriver for electrician's use. Handle A is made of red fiber by turning an 8-in. length of 1¼-in. square or round stock down to 1⅛-in. diameter and knurling this except one end, which, for a distance of 1 in., is threaded for a ½-in. pipe thread.

The handle is then drilled to a depth of 2 in. and the threaded portion split as indicated at E and E, after which the hole is burned out with a square taper rod so as to accommodate the blade shank. After inserting the blade, knurled nut C, threaded the same as the handle, is run into place and tightened, thus securing the blade, which is then further insulated by a piece of rubber tubing, B.

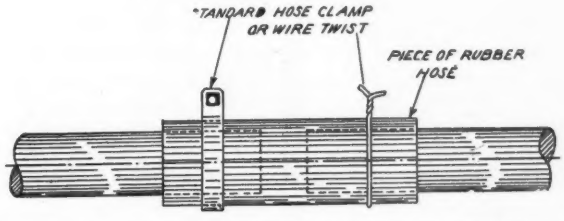
Figure 3 illustrates a grooved flywheel which was fitted for belt drive by filling each groove with three ropes held in place by wire nails in the manner shown.

Figures 4 and 4-A illustrate an all-around boring bar and post for lathe work. Post B is drilled 1/32 in. larger than the bar and the shaded portion filed out, thus making the hole elliptical in form. This allows clamping the bar solidly against ring plate C.

OTTO DORTHEN.

An Emergency Repair for Air or Water Line

AN EMERGENCY REPAIR for broken connections on the air or water line to a rock drill or similar appliance may be quickly and satisfactorily made in the manner shown in the illustration, provided that the pipe is not larger than 2 in. in diameter and that the air or water pressure does not exceed 80 lb. per square inch.



METHOD OF USING PIECE OF HOSE TO REPAIR BROKEN WATER OR AIR LINE

The flexibility of the rubber hose will enable turns to be made around corners simply by lengthening the rubber connection enough to make the necessary bend.

ROY H. POSTON.

Lubricator Repair

IF AN engineer has a lubricator that is so badly sprung that he is not able to make a glass hold because as the stuffing box nuts are tightened the glass will break, just cut a piece of pipe the same size and put in the same as a glass. This is what I did to my sight feed glass, and it is working satisfactorily. You cannot see the feed but you can watch the other glass, which will show how fast oil is leaving the lubricator. The amount can be regulated the same as if you had a glass.

W. N. S.

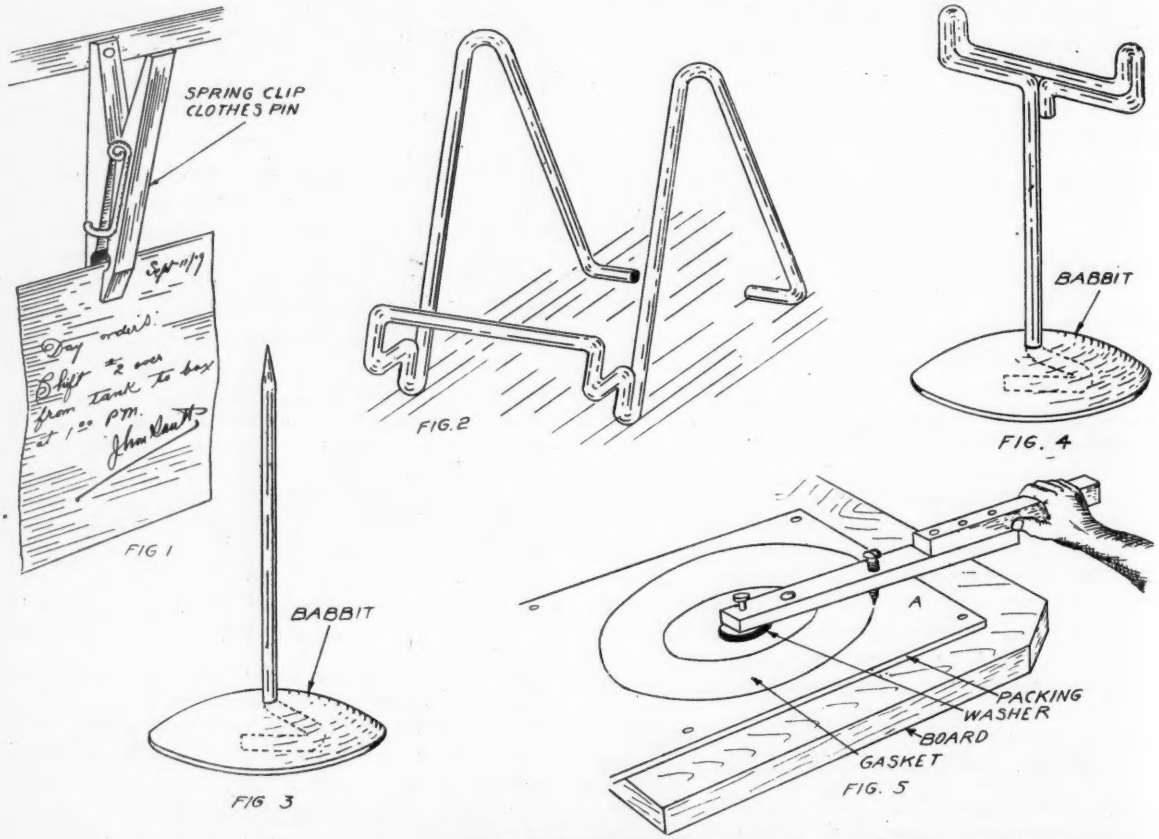
MANY a man's career would have been made if he had accomplished the plans he made, instead of merely deciding to accomplish them.

Five Handy Devices

FIGURE 1 shows how we used the ordinary three-for-a-nickel spring clothes pins for holding orders, etc., over the engineer's desk. One leg of the clip is secured by means of a screw to the strip of wood, fastened to the wall. These clips can also be used on the bulletin board for holding notices.

Some uses for old babbit and wire are illustrated in Figs. 2, 3 and 4.

Figure 2 shows an easy way to construct, with the aid of a pair of pliers, a book stand, or an easel for holding a sign, card, etc. Figure 3 shows a bill spike, and Fig. 4 a stand for supporting one end of long work at the bench vise, or, if made in pairs, for stock supports on the work bench to keep a finished bit of shaft from scratches, etc. The bases are scrap lead or babbit, cast around the bent end of the wire, using a tin can cover for a mold.



FIVE HANDY DEVICES

Having recently had occasion to cut a large circular gasket and not having available a pair of dividers large enough to scribe the circles nor a gasket cutter that would swing the circle, the following device was used for both laying out and cutting.

A large board was used for the base (for an extra large gasket the floor could be used), and a couple of battens made to use as a beam. This was used as shown in Fig. 5. A nail was driven through the end and into the packing, where the center of the gasket was to come. A wood screw, with its point filed to a knife edge, was put in the beam at a distance from the nail equal to the radius of the inner circle. After this circle was cut, the screw was moved to the outer circle. The sheet of packing was tacked down and the circles cut out by pressing down on the bar and revolving it. C. H. W.

Emergency Expansion Bolt

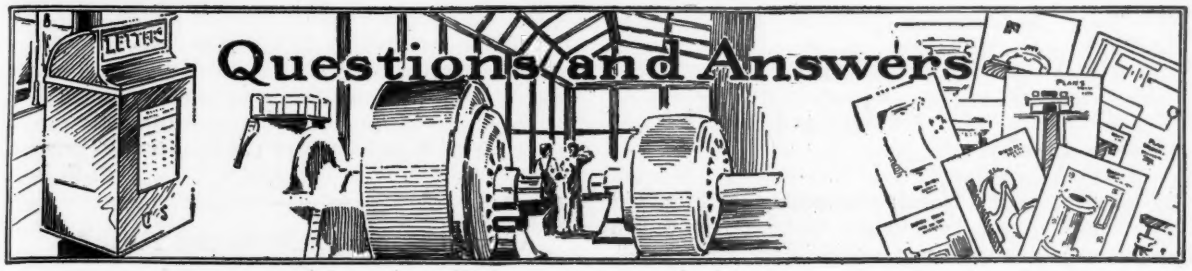
WE HAD occasion recently to use some expansion bolts for attaching wall brackets for supporting a new pipe

EXPANSION BOLT MADE FROM SQUARE HEAD BOLT AND BRASS TUBE

line. As none were available locally, we were thrust upon our own resources and finally made up a number as shown herewith. We took a long bolt, ground off the head so that it was just slightly larger than some ¾-in. tubing which we had. We then cut two pieces of tubing as illustrated, the idea being that when the outside nut was drawn up, the short piece of tubing wedged into the other split section of the tubing, forcing it open and holding the bolt firmly against the walls of the hole.

M. A. SALLER.

Carry yourself with a self-confident air, an air of self-assurance, and you will not only inspire others with a belief in your strength, but you will come to believe in it yourself.



What Changes Would You Make?

THE CARDS shown herewith were taken from a Hewes and Phillips cross-compound engine, which has been running for 15 yr. We recently had new valves, and piston or bull rings fitted. The cylinder and valve chambers were rebored. The engine ran well until recently, when it developed a knock. I took a card of the low-pressure cylinder, and made some changes. The cards show conditions before and after the changes were made.

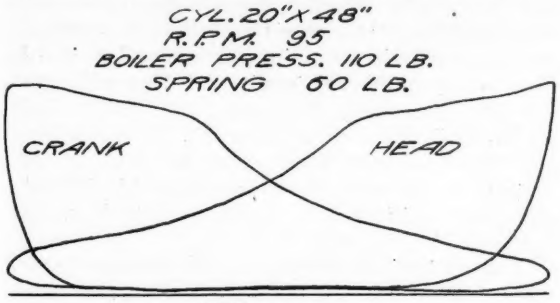


FIG. 1

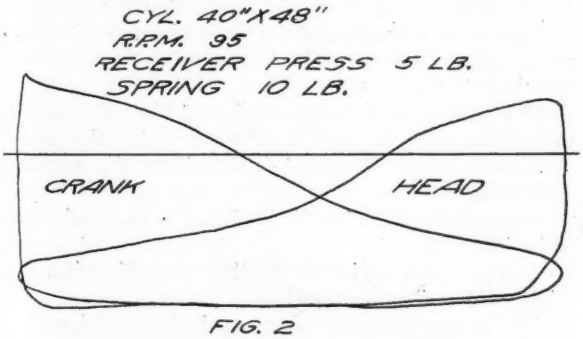


FIG. 2

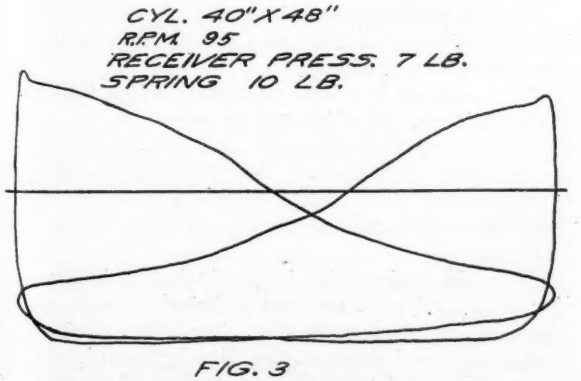


FIG. 3

FIG. 1. CARD FROM HIGH-PRESSURE CYLINDER
FIG. 2. CARD FROM LOW-PRESSURE CYLINDER BEFORE CHANGES
FIG. 3. LOW-PRESSURE CARD AFTER CHANGES WERE MADE

I would like to know how to improve these cards.

J. P.

Reservoir Tapping Problem

SUPPOSE you have a reservoir that is in constant use, cannot be out of service for any length of time, and you want to tap this reservoir for a suction somewhere close to bottom, say a foot. This must be done in haste, for the reservoir must be put back in service at the earliest possible moment. What is the quickest seal around this pipe so as to make it permanent?

Reservoir is 60 ft. in diameter, 15 ft. in depth and has a brick wall 30 in. thick.

I would like to hear from the readers of Power Plant Engineering as to their idea of the kind of material for the quickest permanent seal. R. T.

A Blowoff Pipe Problem

RECENTLY one of our boilers developed a bad habit of breaking blowoffs. This boiler is a 72 in. by 18 ft. horizontal return tubular, and the blowoff arrangement is shown in Fig. 1.

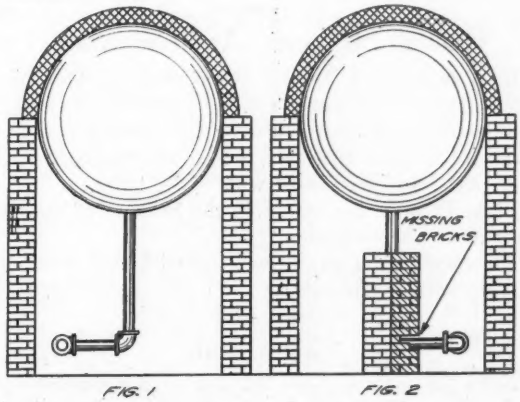


FIG. 1. ARRANGEMENT OF THE BLOWOFF
FIG. 2. FIRE BRICK PIER, TWO BRICKS MISSING

Instead of the usual piping, there is a swing joint in the combustion chamber. The straight-up-and-down pipe leading from the boiler has an ell facing the left-hand side of the boiler looking from the rear toward the front and a short nipple connects this ell to another ell which faces toward the rear wall, to which is connected the pipe leading to the main blowoff line. In front of this blowoff piping is a pier of fire brick, but it will be noticed that in the third and fourth rows up

from the bottom there is a brick missing in each row, Fig. 2.

The ell on the straight-up-and-down pipe always broke off the pipe, and this happened at the time when the boiler was being forced hard and just after the fireman had fired up.

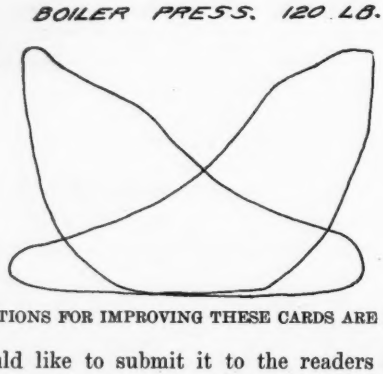
Our theory is that the cold air entering through the fire doors as the fireman was stoking the fires, and passing through the hole in the firebrick pier caused unequal expansion and contraction in the cast-iron ell, which is extra heavy, and the result was a broken ell.

We would like to hear from some of the other readers of Power Plant Engineering on this subject.

S. T. J.

Non-Releasing Corliss Engine Card

THE ACCOMPANYING card was taken from a 14 by 18-in. non-releasing Corliss engine, running on 120 lb. steam, at 180 r.p.m. with a load of 25 amp. at 2300 v.



SUGGESTIONS FOR IMPROVING THESE CARDS ARE DESIRED

I would like to submit it to the readers of Power Plant Engineering for suggestions and comments.

W. S. MOOREHOUSE.

Blowoff Strainers; Are They Safe?

IN A number of 150-hp. horizontal tubular boilers recently installed in our plant, the manufacturers placed mushroom-shaped strainers over the blowoff outlets in the shells. These strainers, which are made of ¼-in. boiler plate, are perforated with ⅜-in. holes.

There is much loose scale in the boilers and they are blown down each morning.

Has anyone had any experience with such strainers? Are they safe or dangerous? C. H.

Grates Burn

NOTE RICHARD A. CARL'S letter on the above subject in the April 15 issue of your magazine, in which he states that he is having trouble by burning parts of traveling grates under a Heine boiler, and also note that he proposes to make some changes in order to remedy the difficulty.

The writer agrees with Mr. Carl as to the bottled furnace condition, and also agrees with him as to the proposed changes, excepting that he cannot place T baffle tile on the second row of tubes of a Heine boiler. I would advise him to place A tile on the third row of tubes. As to the ignition arch, Mr. Carl states that it cannot be raised. This may be so, but the writer feels this is the point where the shoe pinches, and advises raising the ignition arch at least 6 in.

The whole trouble with the installation is that the boiler is set too low for this stoker, and anything that can be done to increase the distance between the grates and boiler tubes will improve the condition in general.

R. F. B.

Comments on Questions and Answers

W. L. N. IN APRIL 1 issue, page 402, seems to take exception to the answer of question 17, and I believe his objections are correct.

When a Corliss engine or any other four valve engine is properly adjusted, there is no further adjustment possible. One person may believe in compression; another may believe in no compression. Let each have his own way on his own engine; but they will agree (I feel sure) that when the governor goes up the limit or out the limit, if a shaft governor, *the steam must be shut off*. When an engine has its steam valves so set that the steam is all cut off on the governor reaching the above-mentioned positions, how can the rods be shortened or lengthened legitimately?

I have a large Corliss-gear engine running at approximately 1000 piston feet per minute and if a toe plate is put on new, the first thing that is done is to test for absolute cutoff.

We do not work on the old theory that it is all right to hook on the amount of the lap. We have seen engines almost go to pieces that hooked on when the governor was "way" up.

If a Corliss or any other engine of like valve gear is to have its speed changed, by all means either change the pulleys or weight the governor but leave the governor rods alone.

Several years ago, in a little village, a new engine was to be installed.

It was a new engine to the little town, but it was a mighty old engine to somewhere.

The engine that was taken out had wheezed until a small addition to the shop had finished its usefulness.

The old pulleys were to be used as far as possible, so it was necessary that the new (?) machine run just an even 68 turns per minute.

It was erected by a local machinist, and he did a good job until it came to adjusting the speed.

They lengthened and shortened the governor's single rod about 40 times and finally got the required 68 turns, but when the full load was put on the speed dropped to about 60 and for a year it was from 60 to 70 r.p.m.

Then the engineer in charge obtained a better position and moved and a new man from out of town took his place. After the new man had been there a couple of weeks, the speed dropped one Monday morning to 60 r.p.m. and stayed right there regardless of steam pressure or load. The superintendent got in touch with the "ingineer" and demanded more speed.

The said "ingineer" gave the "super" a slip of paper which said: "If you want 68 turns a minute you need a new sheave pulley for the governor just exactly 13 6/10 in. in diameter, bored for a shaft 1½ in. in diameter to take a ¾-in. rope. The pulley that is on

the governor now is just 12 in. in diameter and with the cutoff set properly, the engine turns an even 60, where she was probably designed to turn.

"There is no provision made on this engine to weigh the governor so the pulley will have to be changed."

The new sheave was made, the old piece of junk turned 68 under full load and no load with 60 lb. of steam or 90, and once when water got on the main belt and it slid off the pulley onto the engine shaft between the outboard pillow block and pulley, the engineer didn't know anything had happened (he was in the boiler room) until a foreman shouted that the power was stopped.

With the belt off and 90 lb. of steam, it turned only a revolution faster.

I know whereof I speak, brothers, as I was that "ingineer." TOM THUMB.

Disposal of Wood Waste

I HAVE OBSERVED with interest V. C. A.'s inquiry in April 15 issue, page 447. I would suggest a brick chimney or crematory 10 or 20 ft. square, tapering upward to a height of 50 ft. or more, being smaller at the top, and built like a square chimney, covered upon its top with a good, ¼-in. copper wire screening with ½-in. mesh, to prevent sparks from flying out. About 3 ft. above the bottom place good grates with an ash pit door underneath the grates which will allow the cleaning out of ashes, and above the grates an ordinary fire door, which is used in kindling the fire and sometimes to shake it up with a slice bar, should it burn slowly. At about 20 ft. above the grates in the side of the stack, a hole should be cut into which a steel tube 5 ft. long is inserted; from this tube on to the factory sheet-iron tubing is usually used. Through this, surplus shavings can be blown. Where this method is not adopted, a steel conveyor is used in preference to the tube. H. W. ROSE.

What Caused the Bag?

IN THE issue of April 15, J. A. H. asks what caused the bag on one of the horizontal return tubular boilers he was firing. I would say that if the boiler had been thoroughly cleaned and free of oil on the inside, he could not have bagged it as he was firing. He states that everything went well for 45 min.; if so, and he kept the engine running, handled the load successfully and kept the steam pressure up, then it seems that the boiler capacity was ample.

It would require mud, scale, grease or oil on the inside of the plate to cause the overheating; and when overheated, the pressure in the boiler pushed the overheated portion of the plate outward, causing the depression or bag.

If the load was taken care of for 45 min. and steam pressure not permitted to drop, then if the inside boiler surfaces had been as they should be, the load could have been carried successfully for the 5 or 6 hr. required each night.

From what he says, scale was no doubt the cause of the bagging. When scale is formed on the inside of boiler plate and becomes hard enough and heavy enough to prevent the water from remaining in contact with the plate in sufficient quantity to carry off the heat as fast as it is applied on the outside, then the excess heat will cause the plate to become overheated and softened.

While the plate is overheated, the internal pressure acting on it presses it outward; but just as soon as the plate is pressed outward, the scale on the inside is broken, and the water passing through the scale strikes the overheated plate and a miniature explosion takes place. This disturbs the scale considerably, causing it to dislodge and spread about in the boiler, owing to the violent circulation at this time.

Then when the boiler is opened, little or no scale is found directly on the inner surface of the depressed plate. I have heard it said that it requires only a pint of water at the right time and place to knock out the cylinder head of a high-speed engine; and I believe that it requires only about ¼ peck of mud or scale on the right spot at the right time to cause a bag in a boiler plate, and about one ounce of scale or a few drops of oil in a thin tube to cause overheating and the development of a pocket on it.

There is no mystery as to the cause of bagging boilers. That portion bagged has been overheated, and the engineer should be able to determine the cause when he opens the boiler after it has been bagged. Most of the bags on boilers are caused by scale; the next most frequent cause is oil. Eternal vigilance is the price of liberty, and likewise the price of safe and successful steam boiler operation. I. B. LEAVITT.

NOTHING but scale or oil on the shell will cause this. That the shell showed no signs of scale or oil after the damage was done, is because the plate became so hot as to loosen the scale or oil which may have been on the plate. The question as to load on the boiler and engines is very indefinite. He does not give the voltage or kind of current used. Whether the load is made up of motors and lights, or of lights only, he does not state. But, from the way I figure it, he carries some load; and, as he says, he is some fireman.

From the size of the alternators given, I figure that he has a 2300-v. 3-phase system. As he states the load on Saturday night is 170 amp. for 6 hr., $2300 \times 170 \times 1.73 = 676{,}430$ apparent watts, or 676 kw. if his power factor be 1, as on a line supplying current for lights only. Taking the steam consumption for his type of prime mover at 45 lb. per kw.-hr., the total steam consumption for his output will be $676 \times 45 = 30{,}420$ lb. of steam per hr. He states he has two 150-hp. boilers, or 300 b.hp. Using the two boilers at rating, and figuring 33 lb. of water per hp. at 120 lb. pressure, $300 \times 33 = 9900$ lb. of steam per hr. In order to supply the steam for his output, the rating at which the boilers have to be driven will be $30{,}420 \div 9900 = 300$ per cent nearly.

There must be something wrong in that plant. Either his instruments are out, or the power factor is so low that the output is not what it appears to be. Or sometimes engineers have some erratic swings on the board and use these swings as their peak load, which, of course, affects the machines only for a moment.

I would like J. A. H. to give us a little more detailed information in regard to his load; whether it consists of motors and lights and whether I am correct in my assumption as to 2300-v. 3-phase system; what is the value of the power factor? I believe it impossible to

pull a load of that kind with the equipment he has, and do not take it for granted that anybody can operate under these conditions with one 150-hp. boiler.

JAS. BROWER.

IN THE April 15 issue, J. A. H. asks the above question.

It is impossible to burn, bag, or blister a sheet or tube in a boiler if it is free from oil, sediment or anything that will resist the heat transfer from the hot gases in the furnace to the water in the boiler. He said he removed very little scale from the point where the bag occurred, which he thinks did not cause the bag. I would suggest that he ascertain the condition of this sheet, as it may be badly fitted or corroded and, as a result, not have the strength to withstand the pressure.

C. J. MILLER.

What Adjustments Are Required?

I NOTE J. C. E.'s letter on page 447, April 15 issue, in which he requests a remedy for his racing engine. He states that the cards show the valves set correctly, and that the rods are true.

There is still the gag pot to be considered. This plays an important part in the operation of the governor, but is frequently neglected. It should be opened once a year and cleaned with kerosene. If neglected the plunger may stick and cause the engine to race.

A. D. RALF.

IN THE issue of April 15, J. C. E. asks what adjustments are needed to prevent his Corliss engine from racing. There are several causes for an engine racing, but I am of the opinion that his governor does not have a gag-pot, to overcome sensitiveness.

W. S. HOFFMAN.

IN REFERENCE to J. C. E.'s Corliss governor trouble, I would suggest that he replace the original driving pulley with which the engine was equipped when it left the factory, and also the governor pulley, if it has been changed.

Racing or hunting is, in many instances, caused by slippage of the governor belt, owing to the variation of load on the engine. This can be corrected by riveting leather bands around the pulleys, using copper rivets. Another popular method adopted under conditions of this nature, is simply to run your governor belt crossed, which will give the greatest arcs of contact possible with the face of the pulleys and only reverses the direction in which the governor runs, but that will have no effect whatever upon the correct working of the governor.

Should these methods be adopted and fail, the trouble in many cases is located in the dashpot, which will often be found to contain oil that is so thick that the governor will not respond to adjustment of the bypass opening. If such is the case, change the oil entirely, using a very thin oil. In a number of instances, glycerine has been found to give satisfactory results; in other cases even water has been used, a practice which I do not approve, and I have also known of governors in which nothing at all was used in the dashpots. H. W. ROSE.

IN REGARD to J. C. E.'s governor racing as related in the April 15 issue, I would suggest that he install a dashpot on the governor, trying a different oil in it, as thin, medium and heavy, until he gets an adjustment that will stop racing. V. C. WOOD.

Why Does the Bearing Heat?

X. Y. Z. HAS SUBMITTED a problem in the March 1 issue quite beyond my knowledge. I would, however, like to make a few remarks and ask a few questions.

In the first place, the data with the card published is incomplete, in that the boiler pressure or initial steam pressure at high-pressure valve chest is not given, nor is the atmospheric line shown, two very important items in studying indicator cards.

If the high-pressure initial steam pressure is about 85 lb. gage, the receiver pressure is about right for 5 to 10 lb. back pressure. If the initial high-pressure steam pressure is 150 lb. gage, then with 7½ lb. (5 to 10 lb.) back pressure the receiver pressure should be about 52 lb. gage to give equal temperature range in the two cylinders.

After studying the cards for some time, it seems to me that either the gages are wrong or there is a serious obstruction in the exhaust passages between the cylinder and the connection to the back-pressure gage. Not having the atmospheric line for reference, it is impossible to check the gages from the indicator card. It would be well to check the gages. There may be a leak in the three-way indicator cocks.

I should remove the three-way cocks and piping and take cards from each end with the indicator as near the cylinder as possible. If the cards still looked the same and the gages were correct, I should remove the low-pressure connecting rod, the low-pressure steam and exhaust rods between wristplates and valve arms, and block the four valves in the open position, and also block the crosshead in any position so the piston could not move and do all the work with the high-pressure side, for the card (low-pressure) as published shows a negative total area for both ends, which means that no work was contributed by the low-pressure engine to the crank shaft and the power absorbed by friction in the low-pressure moving parts was furnished by the high-pressure side. Therefore, by cutting out the low-pressure side, less steam will be required by the engine to carry the load than was required by the engine when the cards shown were taken. Of course, there may be times of greater load when the low-pressure side will show some work done. That, of course, cannot be determined from the data.

If there is no half-closed valve in the exhaust line from this engine or other obstruction to a free exhaust, then I think it would help the action of the engine to install a large receiver in the exhaust line as near the engine as convenient. It would give a more uniform exhaust line in the low-pressure cards and smooth out the pulsations in the back-pressure.

I would like to ask whether all the steam from the high-pressure cylinder goes to the low-pressure cylinder, or does some of the receiver steam go direct to the exhaust line or to other uses? If there was a valve in the exhaust line from the low-pressure cylinder which

was nearly or entirely closed and the receiver bled, I should expect to find some such low-pressure cards as shown. The heating of the eccentric could then be accounted for by the fact that there was not enough steam passing through the cylinder to carry enough oil to lubricate the valves, thus causing undue friction.

I know of a case where a condensing compound engine gave trouble because the receiver was bled for a heating system and there was little steam used in the low-pressure cylinder. It was found impossible to lubricate the low-pressure piston during cold weather because there was not enough steam passing through the low-pressure cylinder to carry the necessary cylinder oil.

The answer for that condition is the same as given above; namely, cut out the low-pressure cylinder, as it is only a drag and trouble maker.

From the cards given, I would guess that the exhaust valves on the low-pressure cylinder are either not closing properly or else they are leaking badly. The steam valves may also be in bad shape or poorly set. There is something radically wrong, but what it may be cannot be determined from the cards shown. A very careful investigation along the lines suggested above may help X. Y. Z. to locate the trouble. I believe the trouble is not primarily in the low-pressure cylinder.

C. E. MOULSON.

Answers to Refrigeration Questions of Mar. 15

IN A COMPRESSION system, the ammonia, having done its work of expanding and collecting its capacity of heat in the expansion coils, is sucked out by a compressor and compressed to such a degree that by passing it through a water-cooled condenser, it will revert to the liquid form so as to be available for another refrigerating cycle.

In the absorption system, there are a number of appliances which, working together, take the place of the compressor in the compression system. Of these, there are three which are of prime importance—the absorber, the liquor pump, and the generator. The absorber is connected direct to the suction lines of the expansion coils. It is a receiver into which water is sprayed directly into the ammonia. Owing to its great affinity for water, the ammonia is absorbed and keeps continually flowing from the expansion coils to replace the vacuum formed. The liquor pump then transfers the liquor to the generator. The generator is a cylinder which contains a number of steam coils. In this unit, the liquor is heated and the ammonia, being more volatile than water, rises to the ammonia condensers and the cycle is completed the same as in the compression system.

2. In a double-pipe ammonia condenser, the coils are composed of two pipes, one inside of the other. The ammonia is between the two pipes while the water flows counter-current through the inside pipe.

In the atmospheric condenser, the ammonia flows through single pipes while the cooling water drips over the pipes exposed to the atmosphere.

3. The ammonia compressor stuffing box and that of a steam engine differ inasmuch as the compressor box is much deeper. The compressor box contains an oil seal connected by a pipe with either an oil pump or a lubricator. The compressor stuffing box follower is arranged so as to be more easily adjusted than that of the steam engine, because what would be an unnoticeable leak of steam would be a very serious leak were it ammonia. It is packed with a special oil proof rubber packing, a solid ring alternating with a sectional ring.

4. Ammonia pipes are usually joined together by a specially designed flange union in which a gasket of lead or oil-proof rubber is inserted in a recess in one flange, while a boss on the other flange enters the recess with a close fit and bears upon the gasket. The pipe is threaded into the flanges and well soldered or sometimes made up with a paste compound of litharge and glycerin.

5. The analyzer is a sort of heater or heat exchanger placed in the rich liquor line of an absorption system between the exchange proper and the generator and above the latter. It is in the form of a cylinder containing a bank of pans over which the rich liquor trickles and passes out at the bottom and into the generator. The ammonia gas, rising from the generator, passes out through this appliance on its way to the rectifier and condensers and heats the liquor to a high degree in a manner similar to the heating of feed water in an open heater. Most water spray which has been drawn from the generator by the escaping gas is entrained and carried back into the generator by the liquid, thus drying the gas, while at the same time a great quantity of gas separates from the liquor before it reaches the generator at all.

6. In the direct expansion system, the ammonia or refrigerating medium is expanded in coils which are distributed through the rooms to be cooled. In the indirect expansion system, the ammonia is expanded in coils which are submerged in a tank of brine. The brine, which has been cooled in this manner, is then pumped through the refrigerating coils of the room to be cooled.

Owing to the ease with which temperatures are controlled its safety, and the fact that the cold brine can be held in reserve and used when the refrigerating machine is not operating, the indirect system is much the better for general refrigeration.

7. The frost will leave the expansion line and the bottom of the drum immediately beneath the outlet pipe will frost or become very cold. The only way to be absolutely certain, however, is to weigh the drum and compare your weight with the manufacturer's tare weight.

8. A charge is introduced through an appropriate connection into the liquor line between the guard valve of the receiver and the expansion valve, the guard valve being closed at the time.

9. The term "brine tank" is usually applied to the tank which contains the ice cans and expansion coils surrounded by brine, while the term "brine cooler" is applied to an appliance in which the brine is cooled by being forced through pipes or tubes whose walls are in contact with expanding ammonia.

10. If the system is in good condition, nothing will occur; however, if there are leaks on the low side, air, or even brine from the brine tank, may be drawn into the system as it is now operating on a vacuum. The rods of the compressor will be inclined to warm up if the machine is operated in this manner for any great length of time. Owing to the inefficiency of operation and risks of unknown leaks, running the machine with a vacuum should not be tolerated except when pumping out the low side for repairs.

LOE ADDY.

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Turning to Oil

Ever and rapidly mounting coal prices, delivery interruptions due to labor troubles at mines and on the transportation systems, lack of adequate local storage facilities to tide over such periods as when deliveries are impossible, and an acute labor shortage, are, in fact, the primary causes of plant operators turning to oil as fuel.

The use of oil as fuel is not of recent origin, design, construction and installation methods of the equipment required are long since beyond an experimental stage and the means by which oil-fired steam boilers may be operated most efficiently and economically are well known to many engineers, especially those in charge of power plants along the Western Coast. Comparatively speaking, the equipment required for the handling of the oil is extremely simple, although, as in the case of coal-fired plants, satisfactory results may best be obtained by recognition of and adherence to the engineering principles involved. When such equipment is original in a plant, the design and construction may well follow current practice; but should the equipment not be original and the problem resolve itself into one relative to the changing over from coal to oil burning, many perplexing situations are apt to arise as a result. Some of these may be of a purely engineering nature and of ready solution; others, while not of an engineering nature in the strict sense of the word, may, in fact, resolve themselves into more or less engineering problems; still others may be entirely foreign to engineering. At any rate, the work as a rule is bound to tax the ingenuity of the average engineer, and this especially so, in view of the fact that but little authentic information on this most important and timely subject has heretofore appeared either in text or periodical form. That already published is more general than specific in nature, and is, therefore, as a result, of comparatively little value to the man anticipating the job of converting a coal-fired installation into one using fuel oil.

Already many valuable discourses on the subject have been presented to the readers of Power Plant Engineering, but as yet none has appeared which involved such specific data applicable to actual practice as does the leading article of this issue. Excessive labor and coal haulage costs were the predominating factors responsible for the decision in favor of the installation of oil burning equipment in one of three boiler rooms, although as a result of the conversion a costly coal handling system was eliminated and the steam generating capacity of the plant materially increased without the addition of more boilers.

One of the interesting features of the installation cited is the use of a reinforced concrete tank for the storage of the oil. While such use of concrete is not unusual, it has as yet not been generally adopted, it is not only feasible but has been proven entirely practicable, the specifications presented may be of material value to those desiring the employment of a similar means of fuel oil storage. Of particular interest is the means employed to render the service tank, also a reinforced concrete structure, leakproof.

Evaporative tests conducted in the boilers first with the use of coal as fuel and then when oil-fired have conclusively demonstrated the economy of the latter in this particular installation.

Metric Compulsion

Anybody who wants to, or finds it advantageous, is free to use the metric system for measurement and computation in these United States. Why should an enthusiastic faction wish to compel everybody to use it, regardless of preference, convenience, or expense? We confess to a considerable preference in our choice of hats, collars, ties, literature and music. Just why should we be compelled to accept the other fellow's taste in mathematics and measurement?

If it can be shown that the use of English units is having a harmful effect on the health or morals of the nation, or of individuals, we would waive our preference and accept the inconvenience. But we have seen no such proof. And it is indisputably convenient and natural to divide units into halves, quarters, thirds, eighths and sixteenths in measuring, a division that does not tie in readily with decimal divisions. But decimal division of the foot and inch are commonly used where they are desirable.

The main argument advanced for metric compulsion seems to be the greater convenience in computation of having the decimal relation between units of the system and an assumed advantage in export business.

As to the former, transformation from one unit to another in actual business transactions is not so frequent as the examples in school text books might seem to indicate. Nobody buys or sells lumber by the square yard or textiles by the foot. Machinery dimensions are almost entirely in inches, and for building construction the convenience of a dimension of, say, 10 ft. 4 in. would seem as great as that of 3.1495 meters or, even changing to even metric dimensions, of 3.2 meters. We measure water in cubic feet, excavation in cubic yards and do not jumble our units, and the chance for getting the decimal point wrong and thus causing error is surely greater than of mistaking inches for feet, feet for yards or cubic feet for cubic yards in a computation or in a result.

As to whether a metal strip in Paris or one in London shall be our ultimate standard of length seems of little practical consequence; but it would be of quite some consequence if compulsory metric measurement forced the changing of shop tools, jigs, dies and instruments. As an instance, the American Locomotive Co., taking over the manufacture of a French automobile, found it desirable to change the dimensions to English units, and the shop cost for the items mentioned was $90,000. Change in the reverse direction would have cost as much, and this was for a single style of car, which gives some idea of the expense that would be loaded upon manufacturers by compulsory metric legislation.

As to export conditions, E. R. Frost, of the National Machinery Co., calls attention to the following. In England, Norway, Denmark, Sweden, Russia, Germany, Austria, Australia and Japan, and in Central America and South American countries, either Whitworth or U. S. Standard threads are used almost exclusively; both are computed and manufactured in English dimensions.

The manufacturer for export must furnish these threads, and will, therefore, under metric compulsion, have to deal in a double system of measurements, resulting in endless confusion and errors. France and Belgium, while using metric threads at home, use the Whitworth threads for export. They have the confusion, but is that a reason why it should be foisted by law on American manufacturers?

Again we ask, why, when anybody can legally use whichever system best serves his purpose, should a faction seek to enforce their preferences on the rest of the nation?

Greater saving in world business would come from a universal unit for monetary values. Why not ask compulsory use of the franc as a standard of values? Or of the mark, or the crown, or the yen, or the ruble?

It would seem that the people of the United States might be trusted with freedom of choice as to the units and system of measuring and weighing which they can use to best advantage, rather than to force by law and autocratic compulsion standards whose advantage is, to say the least, open to argument. Congress may well busy itself with remedying ills about whose evil effect all are agreed, rather than spend time in considering a law which would meet much well-founded opposition, and those who disapprove of autocratic compulsion of the use of metric standards may well let Congress know their views, or they may find themselves commanded to buy cloth by the meter, sugar by the kilogram, gasoline by the liter and collars by the sizes in centimeters.

Our Postal Service

The intolerable conditions of the postal service in the cities throughout the country have been steadily becoming worse. For months, printed matter and parcels have been subjected to ever-increasing delays, and recently the first-class mail was caught in the jam. In consequence of these delays, business firms are losing millions of dollars. Business is held up, important transactions are blocked, and production is being retarded. It is hurting everybody and benefiting nobody. Overcrowding, inadequate salaries, and inefficient help have demoralized the service to the point of actual disintegration. But the greatest individual sufferers are probably the employes themselves—the men who handle the mail.

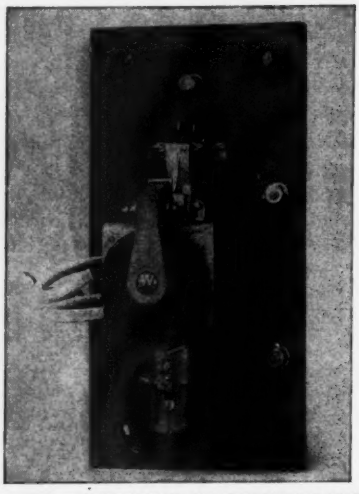
Congress recognized the serious nature of the outlook over a year ago and a joint commission on postal salaries was appointed to deal with it. If it was the intention of this commission to relieve the situation and improve the conditions, it has failed.

An efficient postal service is vital to the country's interest, and if a commission is to be of any use, that must be the ultimate result of its investigations. The object of attainment as well as the method of attainment should be considered. The employes are entitled to justice. An improvement in the situation of this nation-wide question is imperative, and an increase in the salaries of the employes is a logical step towards that end.

New Type of Signal or Trip-Free Relay

THE RELAY shown herewith may be used either as a signal relay or a trip-free relay. As a signal relay, it operates an audible or visible signal to notify the attendant that a circuit-breaker has been tripped automatically. The trip-free relay prevents holding in an electrically-operated device such as a circuit-breaker while an abnormal condition exists on the circuit.

When used as a signal relay, the contacts are normally held latched in the open position. In operating, this latch is released by a coil in series with the circuit-breaker trip coil and is reset by a coil connected across the control circuit. When automatic tripping occurs, current passes through the latch release coil, and the signal circuit is closed. The contacts will remain closed until the circuit of the reset coil is closed by means of a push button. The reset coil latches the contacts in the open position, and the relay is ready for another operation. The signal is actuated only when the tripping is due to the action of automatic devices and does not operate when a circuit-breaker is opened manually.



NEW TYPE OF SIGNAL OR TRIP-FREE RELAY

When used as a trip-free relay, the contacts are also normally held latched in the open position. When the circuit-breaker is opened automatically, the circuit-breaker closing circuit is opened. When the trouble has been removed from the lines, the controller is moved to the trip position, thus resetting the trip-free relay, and closing the circuit-breaker closing circuit. The circuit-breaker may be closed automatically. Tripping by hand does not introduce the trip-free feature, since moving the controller to the trip position automatically resets the trip-free relay.

The signal relay is intended for direct current only, though it may be supplied for alternating current operation. The standard voltage coil may be used on control circuits of 100 to 250 v. For voltages below this, a special coil must be used, while for higher voltages, a resistor must be inserted in series with the coil. The latch release coil is rated in accordance with the current required by standard trip coils, and relays can be supplied for ½, 1 and 3 amp.

The signal relay has its main coil wound for voltage operation, and its release coil wound for current operation. All coils are designed for momentary operation only, and are so connected that they are in the circuit only for the time required by the operation of the apparatus.

A Novel Compression Coupling

IN THE construction of the compression coupling shown herewith, a somewhat novel scheme is employed. Essentially this coupling consists of a tapered, slotted steel sleeve, threaded on the outside and over which ring nuts are screwed. Great compression is thus secured on the shaft by means of these tapered nuts.

APPLICATION OF COMPRESSION COUPLING

The outstanding features of this coupling are the absence of bolts, key seats and otherwise expensive fittings. It is self alining, as strong as the shaft itself and is free from all projections such as set screws and so forth which may catch in the clothes of workers.

Vacuum Tube Type Electrostatic Glow Meter

INDICATION of potential, ground detection, and synchronism indication are the three uses to which a recently developed electrostatic glow meter can be placed. This device consists essentially of three vacuum tubes. When used as a ground detector or potential indicator the device is connected so that one of the bulbs is in parallel with the bottom section of each of the three insulator columns.

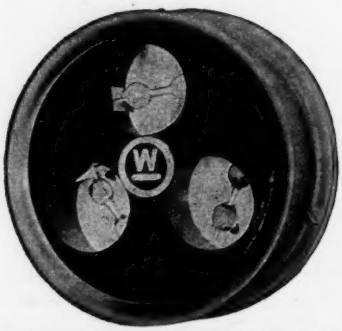


FIG. 1. EXTERIOR VIEW ELECTROSTATIC GLOW METER

When used for synchronizing between a bus and a line or between two lines or two busses the glow meter is connected as follows: The phase connections through one of the bulbs are made such that it will not glow at synchronism. The phases of the two lower bulbs are crossed so that they will glow at half brilliancy at synchronism. When out of synchronism, there will be an apparent rotation which will be an indicator as to whether the incoming line is fast or slow.

For switching these instruments, small oil switches

may be used so that it is possible to use one glow meter for a number of purposes; that is, if enough oil switches are provided.

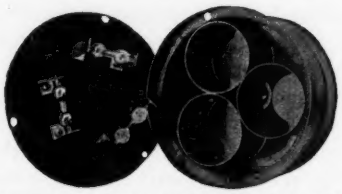
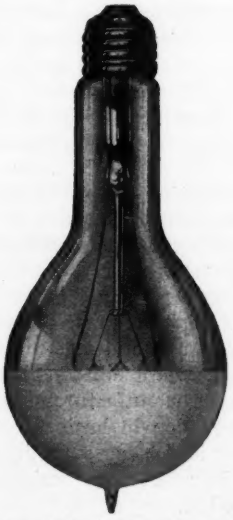


FIG. 2. INTERIOR VIEW ELECTROSTATIC GLOW METER

The base on which the apparatus is mounted is of micarta insulation. The small bulbs are filled with a rare gas which has the property of giving forth a vivid orange-red glow on an extremely small static discharge. They are mounted on spring clips and are separated from each other by micarta tubing.

A New Industrial Lighting Lamp

BOWL-ENAMELED Mazda C lamps, which in the past have been listed as special and have been used in industrial installations under various conditions for some time are now standardized and may be regularly handled by agents. The bowl-enameled lamp is an important addition to industrial lighting equipment, especially since it is of greatest service in conjunction with the R L M standard reflector.



BOWL-ENAMELED LAMP FOR INDUSTRIAL LIGHTING

Essentially this is a Mazda C lamp with a white enamel superficially applied to the bowl of the bulb. The enamel reflects light toward the base of the lamp, and appears, from the outside, as a soft, white, "eggshell" surface. When lighted, a bowl-enameled lamp can be viewed from the tip end at close range without discomfort. The great advantage of this new lamp is that it reduces glare.

The enamel is durable and will not chip off. Acid fumes do not affect it. When lamps are burned in the usual tip-down position the enamel will not discolor during the life of the lamp. A bowl-enameled lamp can readily be washed in warm water and because of its smoother surface does not collect dirt as readily as a frosted lamp.

Bowl-enameled lamps are made in 100, 150, 200 and 300-w. sizes in the 110-v. class and in 100, 200 and 300-w. sizes in the 220-v. class.

Taken alone, the bowl-enameled lamp would not be an unusually important development; but in view of the recent tendency toward standardization in lighting equipment, and because of the fact that this new lamp used with the R L M standard reflector will meet the requirements of the great majority of industrial plants in the country, it is one of the most important developments since the announcement of the Mazda C lamp itself.

Manning Leaves Government Service

DR. VAN. H. MANNING, director of the Bureau of Mines, Department of the Interior has tendered his resignation, effective June 1, to President Wilson. Dr. Manning is leaving the government service to accept the position as director of research with the recently organized American Petroleum Institute, the most important body of petroleum men of the country.

In his letter to the President, Dr. Manning says: "I hereby tender you my resignation, to take effect June 1, 1920, as director of the Bureau of Mines.

"It will be with reluctance and deep regret that I shall sever my connection with the Department of the Interior after 34 yr. of active service therein, and it is the opportunity of being able to continue in another capacity the work for the advancement of purposes fostered by the Department that has been the chief factor in determining my decision to resign.

"I take this opportunity to express my sincere appreciation of the confidence that you have reposed in me as a public official and of the cordial co-operation of the departmental executives whom I have been able to serve. Especially I appreciate your constant help in my efforts to develop an organization that has at heart the welfare of the public, the advancement of the mineral industry, and the safety of the two million workers who contribute to the success of that industry.

"In leaving the government service there comes to me, as it has over and over again, the thought that, although this government spends each year many millions of dollars in useful scientific work for the benefit of the whole people, the monetary recognition of its scientific and technical servants is not sufficient to enable them to continue in the service for the people. This has been especially true within the last few years when it has been impossible for many men to remain in the government service.

"With the marvelous expansion of the industry in this country and the growing necessity of science to industry, the scientific bureaus have been utterly unable to hold their assistants against the competition of industry, which is taking their highly trained men at salaries the government does not pay or even approach.

"I feel very deeply that there ought to be more adequate compensation for the scientific and technical men in the government service, so that none of them may be compelled to accept positions on the outside.

"Many of these scientific men are of fine type for government work, care little for the commercial field, take an intense professional interest in their tasks and are of inestimable value to the government,"

Water Power Development in Canada

THE DOMINION Water Power Branch Department of the Interior, and the Dominion Bureau of Statistics, Department of Trade and Commerce, have, through co-operation, just completed an exhaustive census and analysis of the developed water power in Canada. The figures are exceptionally interesting and indicate the marked manner in which the water power resources of Canada are being put to advantageous use. Practically every center in Canada is now served with hydroelectric energy and has within easy transmission distance ample reserves of water power.

The total water power resources of Canada are placed at about 20,000,000 hp. This figure represents the power available at sites at which more or less definite information is at hand.

According to the statistics just compiled, there is installed throughout Canada some 2,418,000 turbine or water-wheel horsepower of which 2,215,000 hp. is actually and regularly employed in useful work. A large number of the plants now operating are designed for the installation of additional units as the market demands. The ultimate capacity of such plants, together with that of the new plants now under construction, total some 3,385,000 hp.

Of the total power installed 1,756,791 hp. or 72.7 per cent is installed in central stations engaged in the development of electrical energy for sale and distribution.

Hydroelectric energy used for many other purposes and industries may be listed as follows: For lighting purposes, 434,813 hp.; in the mining industry, 177,728 hp.; in flour and grist mills, 42,736 hp.; in lumber and saw mills, 37,818 hp.; in other manufacturing industries, 172,955 hp. These figures are evidence of the widespread manner in which Canada's water power resources are being applied to the furtherance of its industrial development.

The total installation of 2,418,000 hp. is comprised of 3370 units of an average capacity of 715 hp. While 3244 of these units are of 100 hp. or under, they contribute only 82,204 hp., or 3.4 per cent. A total of 1,845,427, or 76.3 per cent of the whole, is contributed by units of 2000 hp. and over; 1,391,025 hp., or 57.6 per cent, by units of 5000 hp. and over; 1,029,900 hp., or 42.6 per cent, by units of 10,000 hp. and over; and 160,000 hp., or 6.6 per cent, by units of 20,000 hp. and over. This illustrates the modern tendency towards the installation of large units. In this connection, reference might be made to the 50,000-hp. turbines which are contemplated for the new development of the Hydro-Electric Power Commission at Queenstown.

The central station industry has made great strides in Canada in recent years. A network of transmission systems, which are rapidly being extended from year to year, covers central and southwestern Ontario and southern Quebec. Of the primary power used in the central stations throughout Canada, 91.4 per cent is derived from water power.

The total installed water-wheel and turbine horsepower in hydroelectric central stations is 1,756,791 hp. Fuel auxiliaries installed as stand-bys to these hydroelectric stations, brings the total installed primary capacity up to 1,873,989 hp. The total capital invested in these stations, including transmission and distributing systems, is $369,464,961, or an average of $210 per installed primary horsepower.

With a water power development of 274 hp. per thousand population, Canada stands well in the forefront in respect to availability and utilization of hydroelectric power resources, being surpassed in this respect only by Norway.

News Notes

"ECONOMIC conditions and widespread interest in human relations between employer and employed," says F. C. W. Parker, Secretary, "are sure to make the Second Annual Convention of the Industrial Relations Association of America (formerly the National Association of Employment Managers), one of the livest and best attended of the whole year, outside of the purely political conventions." It is to be held May 19, 20 and 21 in Chicago. To accommodate everybody, special arrangements have been made for the big Auditorium Theater. Comfortable seats are assured for 3641.

The program includes some of America's ablest speakers and offers an unusual opportunity for every employer, executive or employment manager to hear the very latest developments in industrial relations.

Opening on Wednesday morning, May 19, the three-day convention is to be made up of two-hour general sessions mornings, afternoons and evenings. This allows ample time for "round-table" group discussions at the luncheon and dinner hours of all three days.

THE BILL PROPOSED by C. J. Thompson, Representative in Congress, to tax advertising, was discussed at length by the members of the Engineering Advertisers' Association at its monthly meeting at the Great Northern Hotel, Chicago, on April 13, and it was unanimously agreed to enter a vigorous protest against this proposed legislation as being unsound and unfair to business.

The passing of such a bill would tend to curtail the advertising of some manufacturers, which would cause more or less depression in business, and as the crying need of the hour is for more production, it would be most unwise to interfere with business now by passing the proposed tax bill.

The members of the Engineering Advertisers' Association represent about one hundred of the leading manufacturers of engineering products in the Middle West and their opinions on such an important subject should be seriously considered.

THE 1920 spring meeting of the American Society of Mechanical Engineers will be held in St. Louis, from May 24 to 27. The business meeting will be held on Monday afternoon, May 24, to be followed by the discussion of a number of papers on Appraisal and Valuation. Tuesday, Wednesday and Thursday mornings will be taken up by a number of papers of unusual scope and interest.

Among the papers to be presented, the following may be mentioned as of particular interest in connection

with power plant engineering: Appraisal and Valuation Methods, by David H. Ray; Data on the Cost of Organizing and Financing a Public-Utility Project, by the late F. B. Paine; Burning Eastern Coals Successfully on a Conveyor Feed Type Stoker, by L. R. Stowe; Dissipation of Heat by Various Surfaces, by T. S. Taylor. The other papers to be presented cover a wide field of topics.

Trips have been arranged to various places of interest to both the men and the ladies. The evening programs will include a reception on Monday, banquet at the Missouri Athletic Association, Tuesday, and on Wednesday an entertainment at the Municipal Open Air Theater.

Arrangements have been made for trips to be made, following the meetings, to the oil fields at Tulsa, Okla., and the Mississippi River Power Co.'s plant at Keokuk, Iowa.

Book Reviews

THE J. E. ALDRED LECTURES ON ENGINEERING PRACTICE, 1918-1919, paper; 235 pages, 6 by 9; 11 folding plates; Baltimore, 1919.

This book contains a series of lectures on engineering practice given to the undergraduates of the Department of Engineering of the Johns Hopkins University during the year 1918-19. The lectures were designed for furthering and improving instruction in the methods and problems of the practice of engineering, and deal, therefore, with the practical phases, rather than underlying theory. An elementary knowledge of theory on the part of the reader is assumed.

The following titles give an idea of the scope of the series: The Public Service Electric Power System, by Percy H. Thomas; The Human Element in the Machine Shop, by James Hartness; Berthing and Repair Docks for Shipping, by Rear-Admiral Frederic R. Harris, U. S. N.; Safety from the Standpoint of Industrial Efficiency, by C. W. Price; Modern Steel Freight Ship, by D. D. Thomas; Duties of the Young Engineer on the Construction of a Hydroelectric Plant, by H. S. Slocum; Production of 50 Per Cent Ferro-Silicon in the Electric Furnace, by P. H. Falter; Ore Docks on the Great Lakes, by John E. Greiner; Disturbing Currents in Telephone Systems, by John B. Taylor.

DESIGN AND CONSTRUCTION OF HEAT ENGINES, by Wm. E. Ninde; 704 pages, 466 illustrations, 107 tables; cloth; first edition, New York, 1920.

This, the first edition of Mr. Ninde's book takes its place among the best works on the subject of design of steam and gas engines. Authority is added by the author's 20 yr. of practice in design work and by his subsequent work as Associate Professor of Mechanical Engineering at Syracuse University.

The volume is divided into six parts. Part one starts off by giving the present status of the heat engine, and then goes on to discuss the general principles and features of steam engines and turbines, and internal-combustion engines. Part two contains four chapters devoted to thermodynamics of the various types of engines. In part three there are two chapters devoted to mechanical efficiency, and lubrication, and in part four, there are four chapters treating on power and thrust.

Part five takes into account the various forces present in the heat engine, five chapters being devoted to this subject. Part six takes up the actual design of engine parts, each of the main parts being covered by a separate chapter.

The arrangement of the book typographically is good. At the head of each chapter is listed all of the symbols which are used to any great extent therein. A valuable feature is the author's method of concluding each of the chapters, bearing on design, with a number of examples of successful designs from actual practice.

Although appealing particularly to the designer and student of design, this book has a value for the operating man, who desires to know more about his engine, than merely how to run it to the best advantage.

THE RELATION BETWEEN THE ELASTIC STRENGTHS OF STEEL IN TENSION, COMPRESSION, AND SHEAR, by F. B. Seely, Associate Professor of Theoretical and Applied Mechanics, and W. J. Putnam, Associate of Theoretical and Applied Mechanics, has been issued as Bulletin No. 115 of the Engineering Experiment Station of the University of Illinois.

Our knowledge of the breakdown of elastic action of ductile materials, particularly in the case of combined loading, is far from complete. The various theories of combined stress lead to results which differ rather widely when applied to various machine parts or to structural elements, such as thick cylinders, flat plates, crank shafts, webs of girders, etc. The maximum shear theory of combined stress for ductile materials, as expressed by Guest's law, which has gained rather wide acceptance in recent years, assumes that the elastic shearing strength is one-half of the elastic tensile strength. Available experimental results, however, have, in general, failed to justify this assumption. The importance of the limitation imposed by the shearing stress upon the elastic strength of ductile material is, of course, generally recognized. It is of special importance to know the relation between the shearing and the tensile (and compressive) elastic strengths for various grades of ductile and semi-ductile steels. The main object of the investigation herein recorded was to determine carefully the elastic shearing strength of ductile and semi-ductile steel and to find the ratio of the elastic shearing strength to the elastic tensile strength with the hope that definite information would thereby be obtained on the breakdown of the elastic action of various grades of steel and on the limits of theories of combined stress.

Apart from the problem of combined stress, there has been also a lack of knowledge of the correct elastic shearing strength of various grades of steel and of the general nature of elastic shearing failure as well as of methods of determining the correct shearing strength from tests.

This bulletin presents the results of experiments with six grades of steel, three carbon steels and three alloy steels; namely, soft, mild, and medium carbon steel; and vanadium, nickel, and chrome-nickel alloy steel. The elastic strength in tension, in compression, and in shear is given for each of the six grades of steel.

Copies of Bulletin No. 115 may be obtained without charge by addressing C. R. Richards, Director, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Trade News

THE RELIANCE WEIGHING MACHINE CO. announces the purchase of the business of The National Automatic Scale Co., makers of the Reliance automatic grain scale and other automatic recording weighing machinery.

A complete reorganization of all departments has been perfected, including an enlarged engineering staff, which assures prompt shipments of greatly improved and perfected products.

In addition to grain weighing machinery, a complete line for the continuous weighing and recording of bulk materials is manufactured.

New, enlarged and convenient quarters have been provided in the Mallers Bldg., Chicago, in addition to a greatly enlarged factory located in the central manufacturing district of Chicago.

THE KENNEDY VALVE MANUFACTURING CO. announces the appointment of C. H. Kennedy, formerly New York District Manager, as General Sales Manager, with headquarters at the plant, Elmira, N. Y.

Mr. Kennedy's place in New York has been taken by J. S. Hanlon, formerly Boston Representative, and George W. Waters, formerly in the sales department of the New York office, has been made Boston Representative.

An additional sales office has been opened at 208 Mutual Building, Kansas City, with F. N. Decker in charge. Mr. Decker has for many years been connected with the plant at Elmira.

VANCE MCCARTY, general sales manager of Edw. R. Ladew Co., Inc., has been made vice-president of the company. Mr. McCarty's connection with the House of Ladew covers the past 20 yr. and embraces every phase of the leather belting business, including manufacture, sale, branch management and general sales direction. He will continue in direct control of Ladew sales policies, and has retained as assistant general sales manager, Russell B. Reid, another Ladew belting expert with 20 yr. of leather belting experience.

IN ORDER to co-operate fully with the shipping interest on the Atlantic Coast, the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., has recently established a division of its Marine Department at 165 Broadway, New York City. In charge of this department are Frank F. Boyd and Norris R. Sibley, both of whom have had wide operating experience in the marine field.

THE GEORGE T. LADD CO., of Pittsburgh, Pa., has announced the opening of a Chicago district sales office in charge of W. M. McKinstry, the address being 528 McCormick Building. Mr. McKinstry was formerly Chicago manager of the Page Boiler Co., and has had wide experience in all phases of the water tube boiler field.

LAW METALLIC PACKING CO., INC., formerly in Boston, has located offices in the Industrial Exposition of Factory Appliances at the Grand Central Palace, 480 Lexington Ave., New York City, and will handle business from that point as well as from the Boston office.

OWING to the increase in business in its Chicago territory, The Strong, Carlisle & Hammond Co. has found it necessary to change the location of its Chicago office from the Pontiac Building to 17 S. Desplaines St., also greatly increasing its sales force.

AN INTERESTING side light on the development of foreign markets, by progressive American manufacturers is furnished by a catalog, issued by the General Commercial Co., Ltd., Yokohama, Japanese agents of the Wright Manufacturing Co., of Lisbon, Ohio. Their product consists of hoists only, and the catalog in question is printed in Japanese. Mr. Wright is authority for the statement that in foreign countries there is a distinct tendency to favor those American manufacturers who specialize in one product.

He further states that the Japanese have shown a ready appreciation, not only in being addressed in their native tongue, but in having the scientific principles embodied in the manufacture of hoists, and the quality of the material used, thus directly explained and guaranteed to them.

The catalog presents an odd appearance with the title page at the back, and the vertical columns of hieroglyphics. The catalogs are, of course, intended for distribution in the Japanese Empire.

CENTRIFUGAL PUMPS of the single-stage and multi-stage types for various services are described in a handsomely illustrated catalog just issued by the De Laval Steam Turbine Co., Trenton, N. J. Manufacture is on an interchangeable basis, permitting of the supplying of finished repair parts made to accurate dimensions. The present publication describes these and other details, and also explains fully the use of pump characteristic curves in adapting pumps to various services, the adaptation of centrifugal pumps to different types of drives, the information required by the manufacturer in order to design a pump to suit given conditions, etc. Formulas and tables are given for calculating horsepower, efficiencies, the readings of Venturi meters, friction in pipe lines, etc.

THE HOT PROCESS water softener is described in a book recently issued by the H. S. B. W.-Cochrane Corporation, formerly the Harrison Safety Boiler Works, of Philadelphia, Pa. The hot process softener is a modern development of the well known lime-soda process, the difference being that the chemicals are added to the water only after it has been heated to 205 deg. F. or higher, which results in practically instantaneous and complete chemical reactions and in more rapid settlement of the precipitate. The book will be of value to all who are concerned with the operation of steam boilers.

FAST FLEXIBLE Turbo-Coupling is the subject of a catalog containing descriptions and illustrations of a new turbo-coupling whose flexibility is due to design, rather than flexibility of material. The maker is The Bartlett Hayward Co., Baltimore, Md.

CATALOG of Ballwood Pipe Fabrications presents illustrations and accompanying text describing in detail the more common methods of pipe fabrications, and also the specially improved types of connection developed by The Ballwood Co., Passaic, N. J.